

K4XL's BAMA

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OPERATING AND SERVICE MANUAL

MODEL 310A WAVE ANALYZER

SERIALS PREFIXED: 516-

SEE APPENDIX I
FOR OTHER SERIALS

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1501 PAGE MILL ROAD, PALO ALTO, CALIFORNIA, U.S.A.

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Table 1-1. Specifications

Frequency Range:
1 kc to 1.5 mc (200-cps bandwidth)
5 kc to 1.5 mc (1000-cps bandwidth)
10 kc to 1.5 mc (3000-cps bandwidth)

Frequency Accuracy:
 $\pm(1\% + 300 \text{ cps})$

Frequency Calibration:
Linear graduation, 1 division per 200 cps.

Sensitivity:
3 IF bandwidths, 200 cps, 1000 cps, and 3000 cps.
Midpoint of the passband (f_o) is readily distinguished by a rejection region 1 cps wide between the 3-db points.

	200-cps Bandwidth	1000-cps Bandwidth	3000-cps Bandwidth
Rejection*	Frequency (cps)	Frequency (cps)	Frequency (cps)
$\geq 3 \text{ dB}$	$f_o \pm 108$	$f_o \pm 540$	$f_o \pm 1550$
$\geq 50 \text{ dB}$	$f_o \pm 500$	$f_o \pm 2400$	$f_o \pm 7000$
$\geq 75 \text{ dB}$	$f_o \pm 1000$	$f_o \pm 5000$	$f_o \pm 17000$

* Rejection increases smoothly beyond the -75-dB points.

Voltage Range:
10 μ volts to 100 volts full scale. Ranges provided by input attenuator and meter range switch in steps of 1:3 or 10 dB.

Voltage Accuracy:
 $\pm 6\%$ of full scale

Internal Calibrator Stability:
 $\pm 1\%$ of full scale

Dynamic Range:
Greater than 75 dB.

Noise and Spurious Response:
At least 75 dB below a full-scale reference set on the 0 dB position of RANGE switch.

Input Resistance:
Determined by input attenuator; 10k ohms on most sensitive range; 30k ohms on next range; 100k ohms on other ranges; shunt capacitance $< 100 \text{ pF}$ on three most sensitive ranges; $< 50 \text{ pF}$ on other ranges.

Automatic Frequency Control:
Dynamic hold-in range is $\pm 3 \text{ kc}$, minimum, at 100 kc. Tracking speed is approximately 100 cps/sec. Locks on signals as low as 70 dB below a full-scale reference set on the 0 dB position of the RANGE switch.

Restored Frequency Output:
Restored signal frequency output is at least 0.25 volt (meter at full scale) across 135 ohms with approximately 30 dB of level control provided. Output impedance is approximately 135 ohms.

BFO Output:
0.5 volt across 135 ohms with approximately 30 dB of level control provided. Output impedance approximately 135 ohms.

Recorder Output:
1 VDC into an open circuit from 1000-ohm source impedance for single-ended recorders.

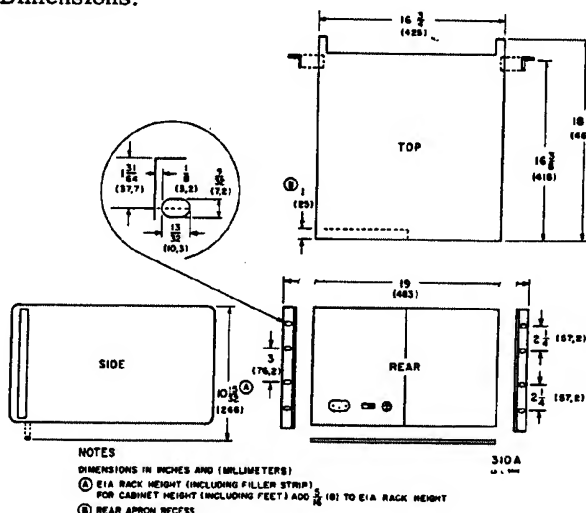
Receiver Function (Aural or Recording Provision):
Internal carrier reinsertion oscillator is provided for demodulation of either normal or inverted signal sideband signals. AM signal also can be detected.

Power:
115 or 230 volts $\pm 10\%$, 50 to 1000 cps; approx. 16 watts.

RFI:
Conducted and radiated leakage limits are below those specified in MIL-I-6181D.

Weight:
Net, 44 lb (21 kg). Shipping, 59 lb (27 kg).

Dimensions:



Accessories Available:

11001A Cable, BNC male-to-dual banana plug, 45 in. (1143 mm) long.

10503A Cable, BNC male connectors, 4 ft. (1220 mm) long.

10111A Adapter, banana plug-to-BNC female, Model 297A Sweep Drive, 11505A Bench Stand for 297A. K02-310A bracket for mounting 297A on 310A front panel.

Options:

01. Internal frequency calibrator providing check points every 100 kc. Interpolation accuracy (between check points): $\pm 2 \text{ kc}$ up to 1.4 mc, $\pm 3 \text{ kc}$ between 1.4 and 1.5 mc.

02. DB scale uppermost on meter face and extended to -25 dB.

SECTION I GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. DESCRIPTION.

1-3. The Model 310A Wave Analyzer separates and measures the various frequency components of an input signal so that the fundamental, harmonics, and intermodulation products may be analyzed. Any input signal component between 1 kc and 1.5 Mc may be located and measured. The only requirement is that it be within the dynamic range of the instrument, and that it be separated from other components by enough more than the selected bandwidth to make an isolated measurement possible (see Table 1-1).

1-4. DISTORTION MEASUREMENTS.

1-5. For measurements analyzing the distortion products in amplifiers, transducers, and other active devices, the Model 310A is provided with a RELATIVE mode of operation in which the reference frequency may be set to an arbitrary level, and the remaining components measured directly with respect to that reference, in either percent or dB.

1-6. ABSOLUTE MEASUREMENTS.

1-7. Alternatively, the Model 310A may be operated in an ABSOLUTE mode, under which conditions it acts as an accurate, tuned AF-RF voltmeter, measuring the amplitude of the components of any signal within its range to an accuracy of $\pm 6\%$.

1-8. RESPONSE MEASUREMENTS.

1-9. In the BFO mode of operation, the Model 310A provides a constant-amplitude sine-wave output, at the frequency of the dial setting, for measuring the response of amplifiers, passive networks, or transmission systems.

1-10. AUTOMATIC FREQUENCY CONTROL.

1-11. In the AFC mode of operation, the Model 310A will lock on to and follow signals which have a drift rate as high as 100 cps/second. The dynamic hold-in range is ± 3 kc (at 100 kc).

1-12. RESTORED FREQUENCY OUTPUT.

1-13. The component of the input signal which lies within the passband of the Model 310A is available at the OUTPUT terminal. Using this restored frequency output with an electronic counter makes possible the precise determination of the frequencies of intermodulation and other distortion products.

1-14. RECEIVER FUNCTIONS.

1-15. Single-sideband and amplitude-modulated signals may be received, detected, and monitored at the OUTPUT terminal.

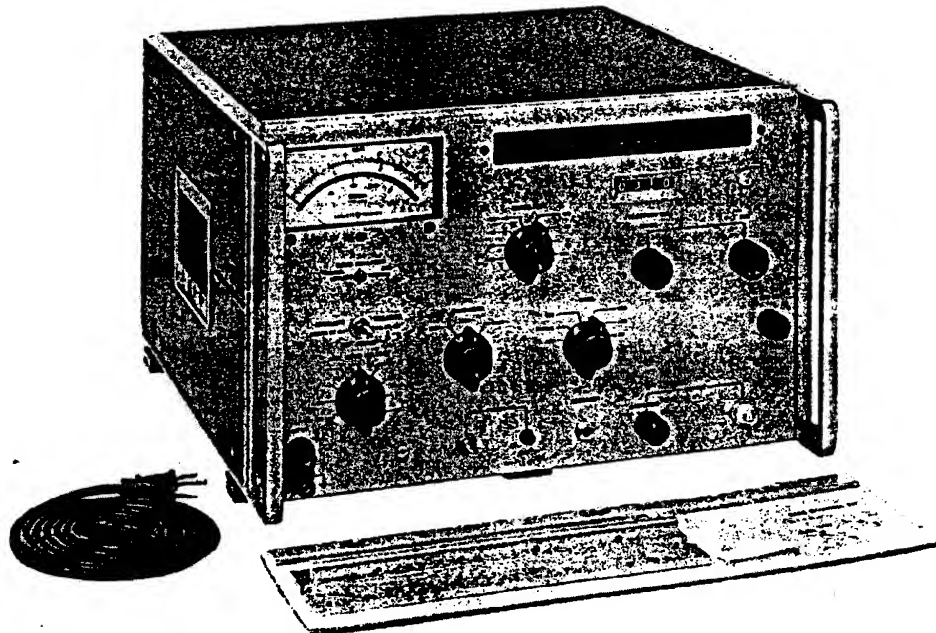


Figure 1-1 Model 310A Wave Analyzer

1-16. APPLICATIONS.

1-17. The Model 310A Wave Analyzer is designed primarily to measure harmonic or intermodulation products in active circuits such as amplifiers, receivers, or transmitters, and carrier telephone systems. The instrument measures intermodulation distortion by either the SMPTE (Society of Motion Picture and Television Engineers) or the CCIF (International Telephonic Consultative Committee) method. In addition, the Model 310A measures the response of amplifiers, passive networks, and transmission systems up to 1.5 Mc. Its linear frequency dial and lack of band-switching make motor drive and automatic plotting a simple procedure.

1-18. INSTRUMENT IDENTIFICATION.

1-19. Hewlett-Packard uses a two-section eight-digit serial number (on instrument rear panel) to identify instruments (000-00000). The first three digits are a serial prefix used to identify instruments to published literature. If the first three digits of the serial number on your instrument are not the same as those which appear on the title page of this manual, there are differences between your instrument and the instrument described in this manual (refer to Appendix 1 of this manual).

1-20. ACCESSORY SWEEP DRIVE.

1-21. The $\text{\textcircled{H}}$ Model 297A (Figure 1-2) is a motor drive unit designed to sweep tunable devices such as the Model 310A. The Model 11505A Bench Stand is available for mounting the Model 297A. Two sweep speeds and a neutral are provided, together with an output voltage proportional to dial position for driving X-Y recorders. Also, available is a special bracket kit ($\text{\textcircled{H}}$ Model K02-310A) which permits the Model 297A to be mounted directly to the front panel of the Model 310A.

1-22. OPTIONS.

1-23. OPTION 01 CRYSTAL CALIBRATOR.

1-24. The Model 310A Option 01 is a standard $\text{\textcircled{H}}$ Model 310A Wave Analyzer which has been modified by replacing

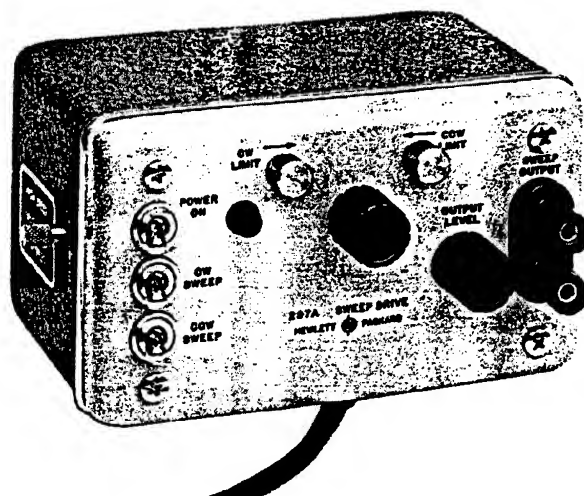


Figure 1-2. $\text{\textcircled{H}}$ Model 297A Sweep Drive

the 100-kc calibration multivibrator (A3Q1, A3Q2, and associated components) with a 100-kc crystal oscillator which may be used for both amplitude and frequency calibration. Details of the modification will be found in Appendix II of this manual. A Model 310A Option 01 Modification Kit is available: $\text{\textcircled{H}}$ Stock No. 310A-95A.

1-25. OPTION 02 SPECIAL METER.

1-26. The Model 310A Option 02 is a standard $\text{\textcircled{H}}$ Model 310A except that the front-panel meter has an extended dB scale, placed uppermost on the face of the meter. The voltage scale is below the dB scale.

1-27. WARRANTY.

1-28. The Model 310A carries the standard Hewlett-Packard Warranty against defects in materials or workmanship for one year from date of shipment. A copy of the warranty is included at the back of this manual.

SECTION II INSTALLATION

2-1. INCOMING INSPECTION.

2-2. MECHANICAL INSPECTION.

2-3. Inspect the Model 310A as soon as possible after receipt of shipment. Should shipping damage be apparent, notify the carrier immediately (see warranty page at the back of this manual). For assistance of any kind, including help with instruments under warranty, consult your nearest Hewlett-Packard field office (see maps at the back of this manual).

2-4. ELECTRICAL INSPECTION.

2-5. A performance check is included in Section V of this manual. Use this check as an incoming inspection procedure, or at any time to verify that the instrument is operating within its specifications.

2-6. INSTALLATION.

2-7. The Model 310A is delivered as a cabinet mount instrument. A kit is supplied with the instrument for

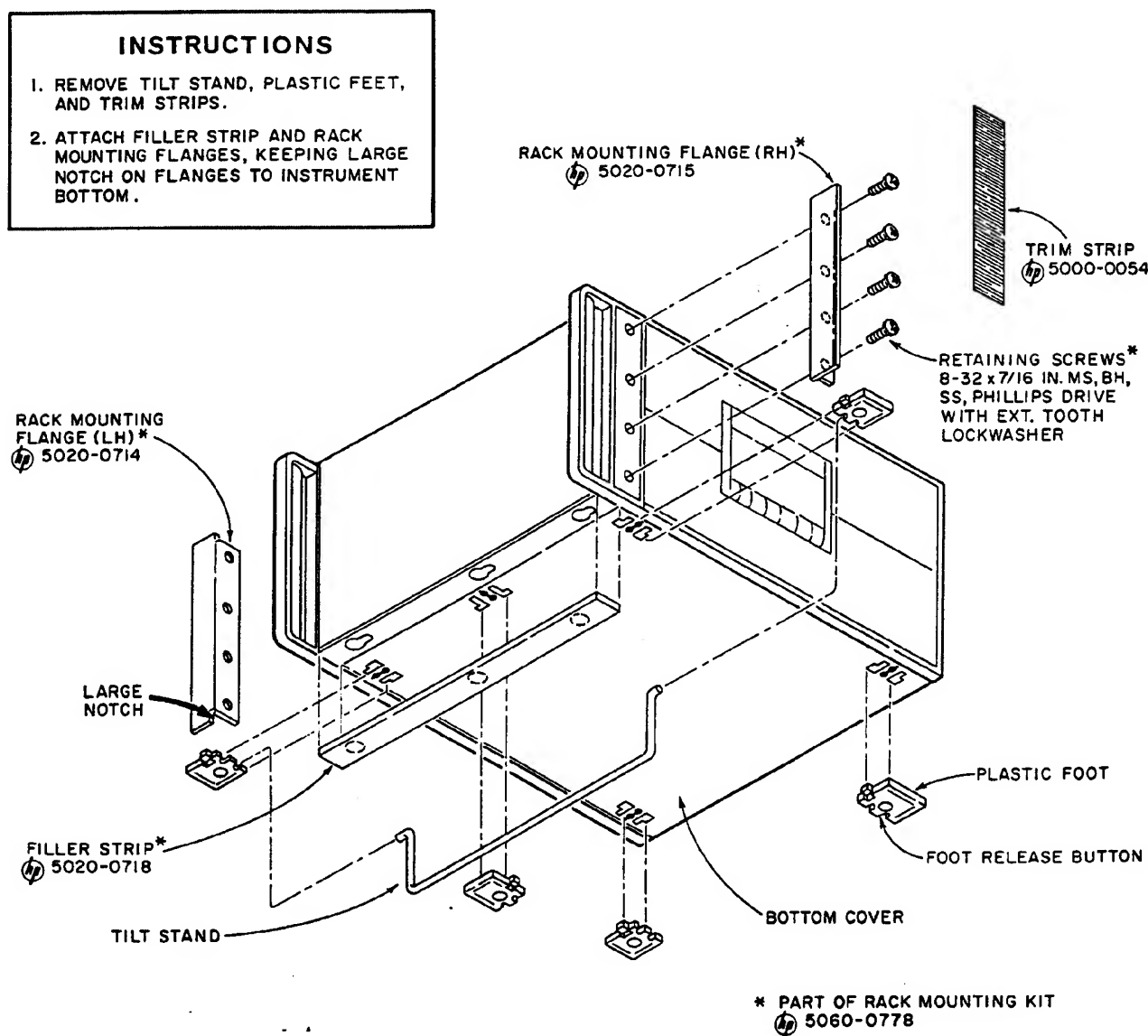


Figure 2-1. Conversion to Rack Mount

conversion to rack mount (refer to Figure 2-1 for rack mounting instructions and list of kit parts).

Note

If the rack is to be subject to shock or vibration, rear support must be provided to bear instrument weight. Alternately, the side handles may be removed and rack slides mounted in their place.

2-8. POWER REQUIREMENT.

2-9. The 310A can be operated from a 115- or 230-volt 50- to 1000-cps source. A two-position slide switch at the rear of the instrument selects ac operation mode. The line voltage at which the instrument is set to operate appears on the slider of the switch. A 0.25-ampere slow-blow fuse is used for either 115- or 230-volt operation.

2-10. SAFETY POWER CORD.

2-11. To protect operating personnel the National Electrical Manufacturers' Association (NEMA) recommends that the instrument panel and cabinet be grounded. This instrument is equipped with a three-conductor power cord which grounds the instrument cabinet when plugged into an appropriate outlet.

2-12. To preserve the protection feature when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter and connect the green pigtail on the adapter to ground.

2-13. REPACKAGING FOR SHIPMENT.

2-14. To protect valuable electronic equipment during shipment, always use the best packing methods available. Your Hewlett-Packard field office can supply packing materials such as those used at the factory. Contract packaging companies in many cities can provide dependable custom packing on short notice. The following steps are a general guide:

- a. Wrap instrument in heavy protective paper.
- b. Protect panel with cardboard strips.
- c. Use a strong cardboard or wooden box.
- d. Use ample packing material around all sides of instrument.
- e. Seal with heavy tape or metal bands
- f. Mark container, "FRAGILE - DELICATE INSTRUMENT".

SECTION III

OPERATING INSTRUCTIONS

3-1. GENERAL.

3-2. The 310A is a highly selective AF-RF voltmeter, capable of accurate measurement of input signal components up to 1.5 Mc. Measurements may be made in calibrated values of volts and dBm or in relative values of percent and dB. A BFO mode of operation is provided, converting the instrument to a signal generator and response meter, suitable for measuring characteristics of amplifiers or passive elements. In addition, signals containing single-sideband or AM information may be detected and monitored.

3-3. FRONT PANEL CONTROLS.

3-4. The front panel controls and connectors are shown in Figure 3-1. Each control and connector is identified with a numbered call-out and an explanation of the function, given in the accompanying text.

3-5. FUNCTION.

3-6. The function of the instrument is controlled by the MODE switch. NORMAL is ordinarily used for tuning the instrument to a signal component that is to be measured, after which AFC can be selected to keep the instrument tuned to that component even though its frequency may vary up to ± 3 kc. In these two modes, the signal passed by the filters in the Model 310A is restored to its original frequency and delivered to the OUTPUT terminals, where it may be measured with an electronic counter if desired. In the BFO mode, the instrument becomes a signal generator, providing a signal at the OUTPUT terminal that has a frequency equal to that set on the FREQUENCY dial. This signal may be used to test the response of amplifiers or passive circuits, the output of the circuit under test being connected to the Model 310A INPUT terminals and measured by the narrow-band tuned voltmeter. The remaining positions of the MODE switch, USB, LSB, and AM, select receiver functions, demodulating upper-sideband, lower-sideband, or amplitude-modulated signals respectively, and delivering the modulation to the OUTPUT terminal.

3-7. BANDWIDTH.

3-8. Three BANDWIDTH settings are provided: 3000 cps is for receiving sideband and amplitude-modulated signals, and is also useful during tuning, to make the desired component easier to find; 200 cps, in conjunction with the AFC setting of the MODE control, allows measurement of a component with minimum noise interference, or in the presence of closely adjacent components; 1000 cps simplifies the calculation of noise-power per cycle-bandwidth. For every measurement, there is a notch one cycle wide at the exact center of the band, allowing the signal component to be set with ZERO SET to the center of the band to take maximum advantage of the AFC range. The

filter have a flat response nearly to band edge, therefore any marked variation of the signal as FREQUENCY is varied will indicate that more than one component is entering the passband. The notch at the center of the band can be used to locate these components

3-9. OPERATING PROCEDURE.

3-10. GENERAL.

3-11. The operating procedures (Figures 3-2 through 2-8) give step-by-step procedures for the various modes of operation. Steps of each procedure are numbered according to the sequence in which they are to be performed, and any control or connector used is identified with the number of the step in which it is used.

3-12. The main purpose of the 310A is to locate and measure the harmonic or intermodulation components of a signal at the INPUT terminals. In most cases, this is accomplished by setting RANGE to 0 dB, selecting RELATIVE, tuning FREQUENCY to the fundamental (or largest component), and adjusting MAX INPUT VOLTAGE and signal level to a meter reading of 1 (for percentage readings) or 0 dB (for decibel readings). Then the remaining components can be found and measured by changing the setting of FREQUENCY and RANGE. In some cases a signal larger than the fundamental component of interest may be present (60-cycle hum, for instance). Such a signal may be outside the tuning range of the instrument, yet will overload the amplifiers that precede the filter unless it is attenuated at the input to the instrument. Such overloading will produce intermodulation distortion within the instrument and result in erroneous readings.

3-13. INPUT OVERLOADING.

3-14. To avoid errors caused by large extraneous signals at the input, tune to any frequency of interest with RANGE at 0 dB, adjust MAX INPUT VOLTAGE for an up-scale reading, not the reading, then rotate MAX INPUT VOLTAGE one step clockwise and RANGE one step counterclockwise. If the meter reading changes more than 6%, input overload is indicated. Repeat the process until no change in reading takes place; then the preceding step is satisfactory. When such overload is present, the reference component cannot be set to 0 dB on the RANGE switch, therefore the dynamic range of the instrument is limited. The only alternative is to eliminate the interfering signal. Once the proper setting of MAX INPUT VOLTAGE has been found, it must not be changed counterclockwise as long as the particular large-amplitude signal is present (unless REF ADJUST is also changed to compensate).

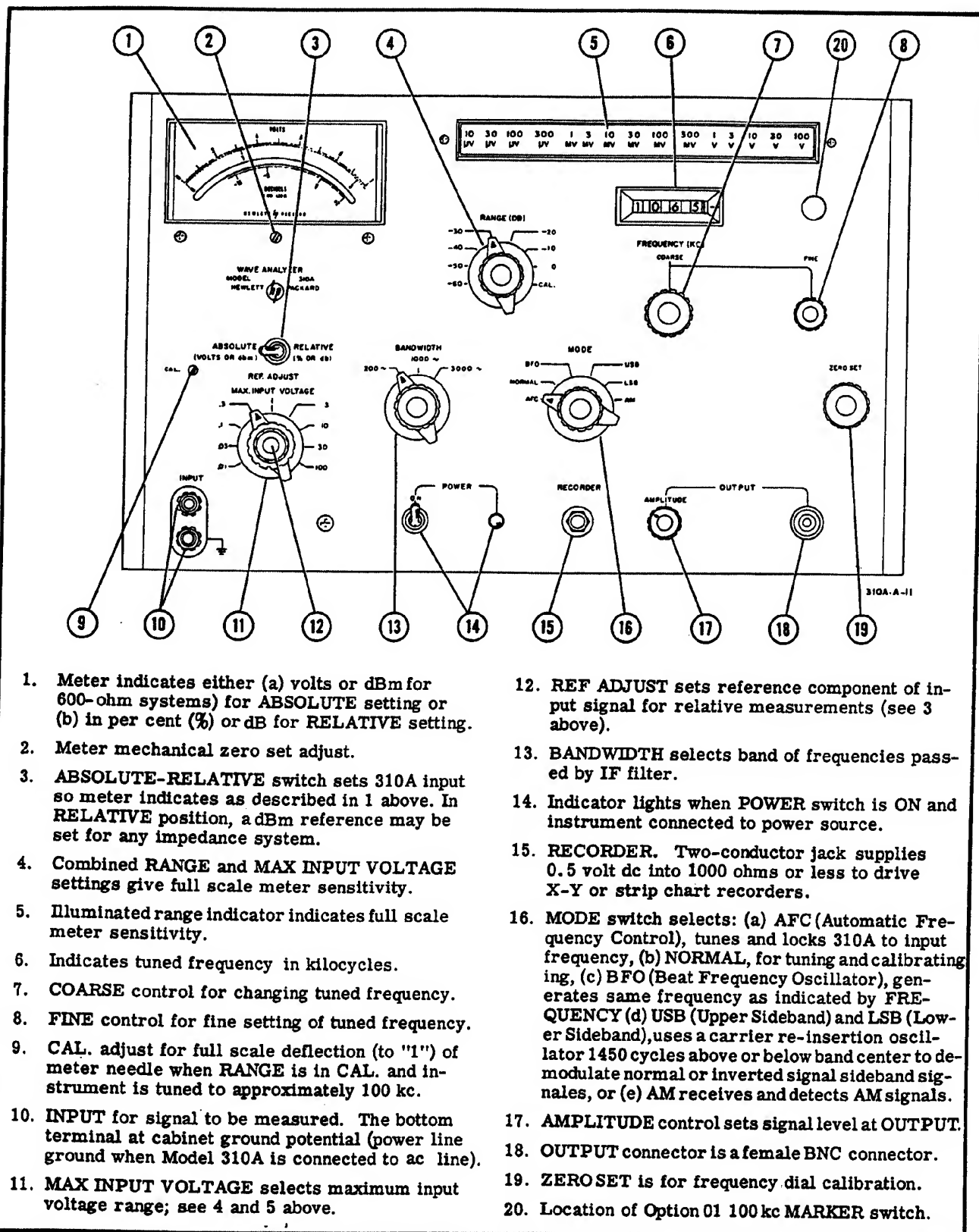


Figure 3-1. Front Panel Controls

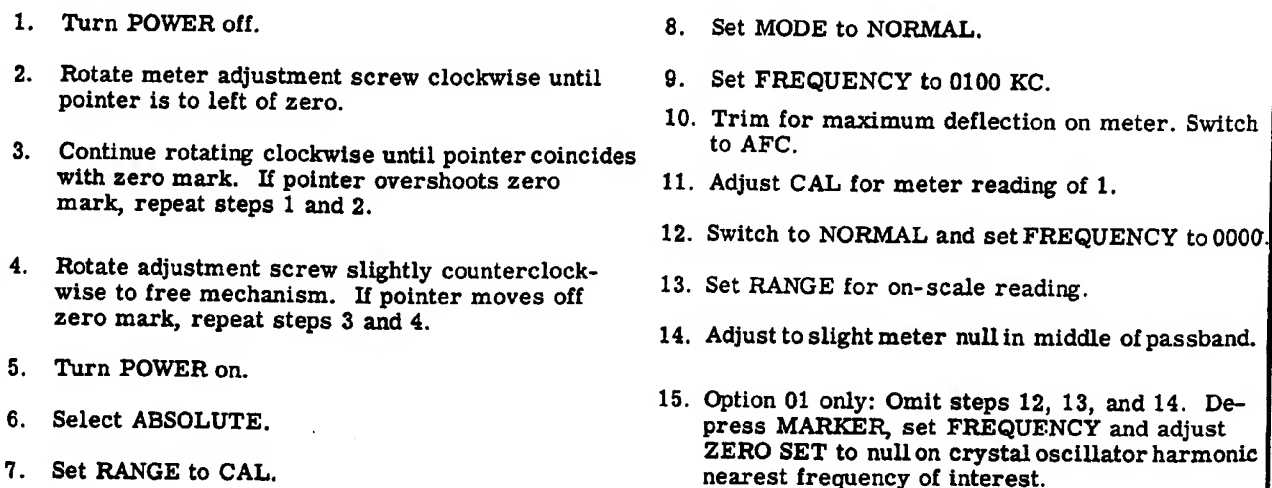
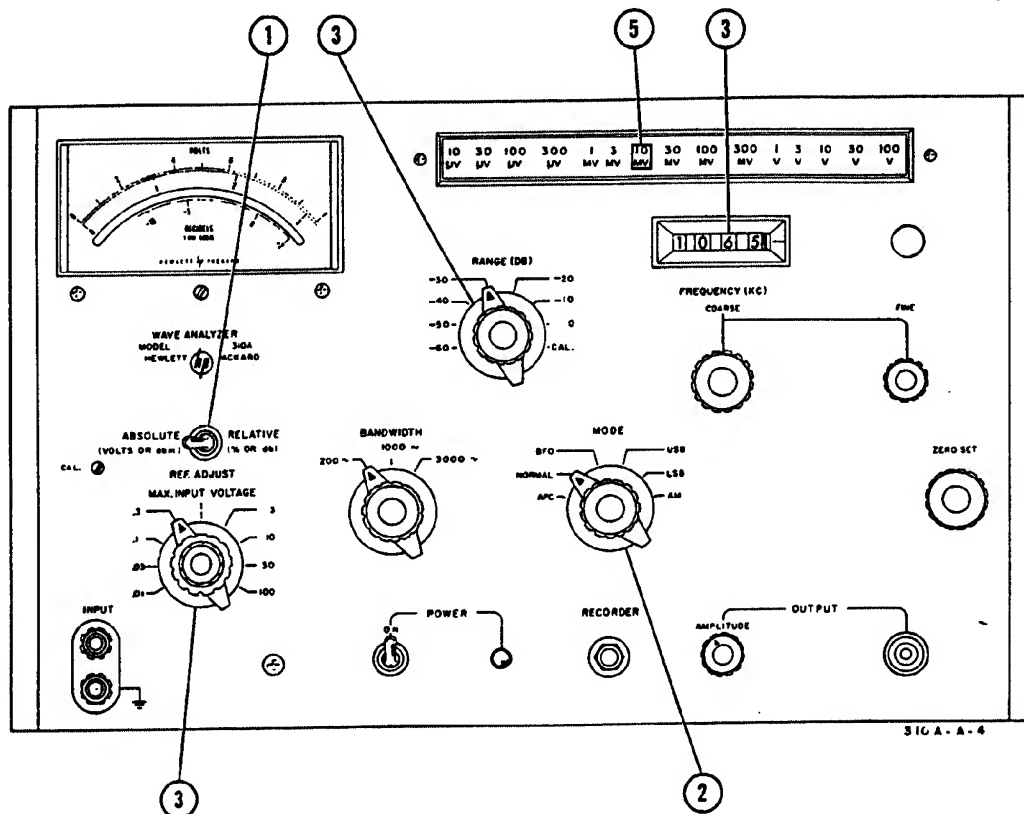


Figure 3-2. Calibration



1. Select ABSOLUTE,
2. Set MODE to NORMAL.
3. Set FREQUENCY to component to be measured, changing MAX INPUT VOLTAGE and RANGE as required (Paragraph 3-15).

Note

Meter reading decreases slightly at center frequency. Increases slightly at either side of center frequency.

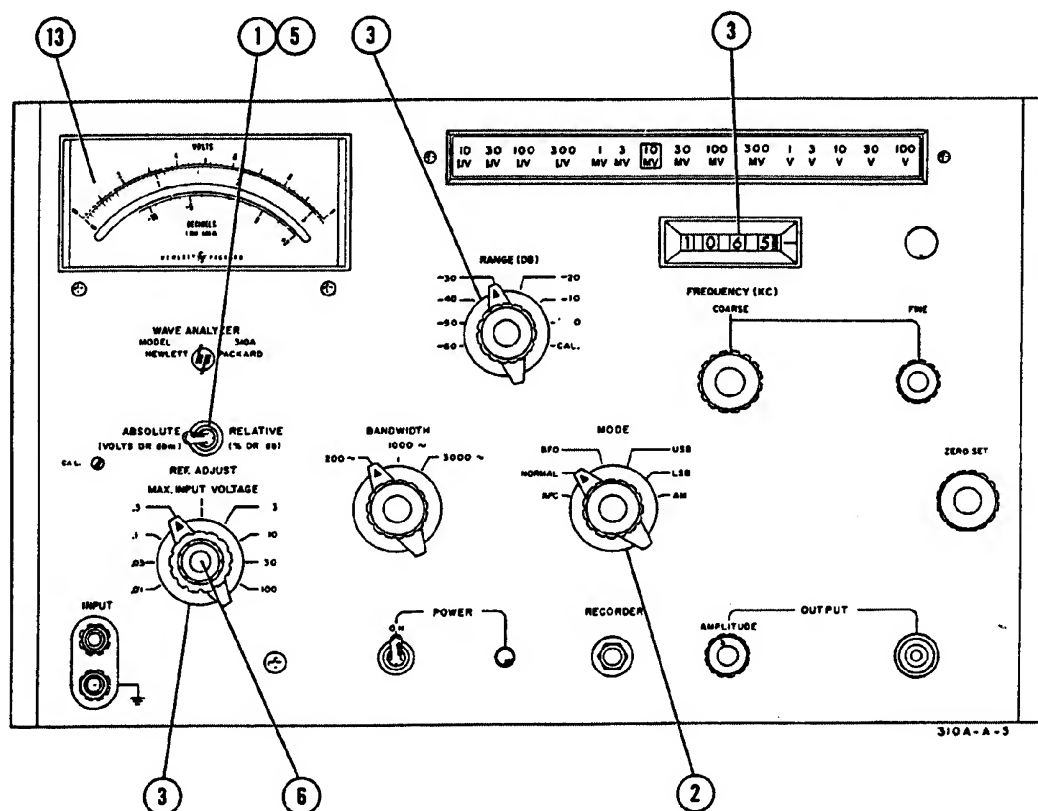
4. Set MODE to AFC.

Note

When set to AFC the meter reading will decrease slightly.

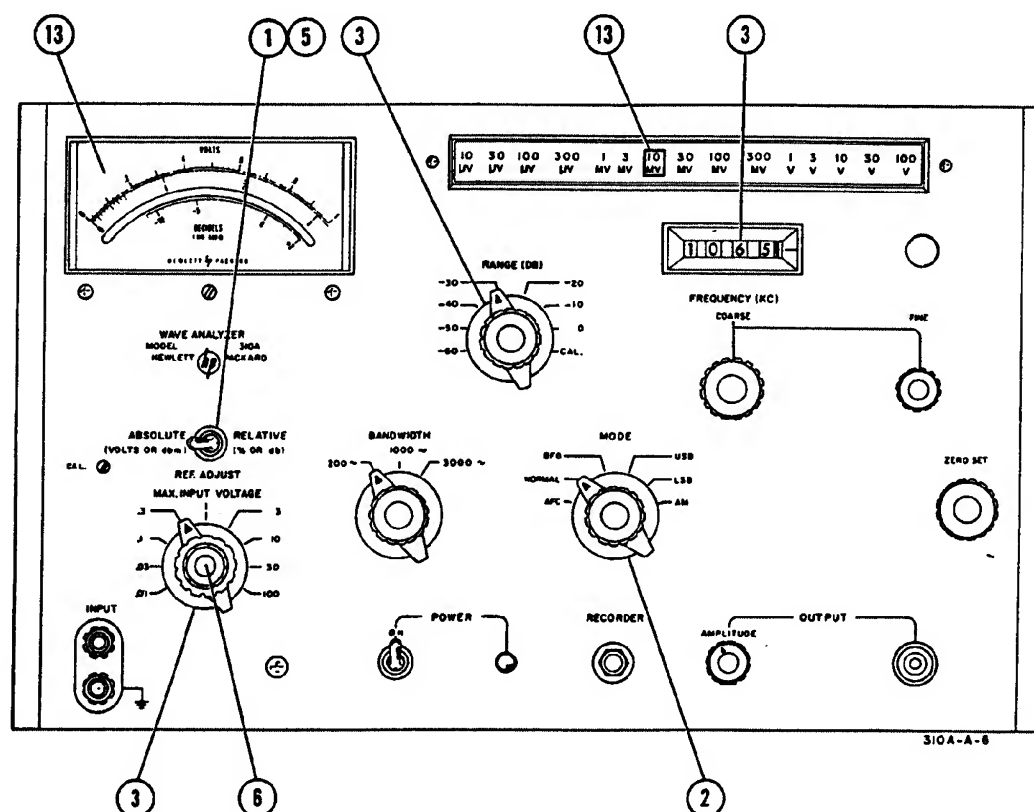
5. The lighted range window now indicates the full-scale voltage range of the meter. To read dBm in a 600-ohm system, subtract 10 dBm from meter reading for each step to the left of 1 V; add 10 dBm for each step to the right. For example, a meter reading of -3 dB and a range indication of 10 mV reads -43 dBm.

Figure 3-3. Absolute Measurements



1. Select ABSOLUTE.
2. Set MODE to NORMAL.
3. Select largest component for use as reference. Set FREQUENCY to that component, changing MAX INPUT VOLTAGE and RANGE as required (Paragraph 3-15).
4. Set MODE to AFC.
5. Switch to RELATIVE.
6. Turn REF ADJUST counterclockwise.
7. Switch MAX INPUT VOLTAGE one step counterclockwise.
8. Turn REF ADJUST clockwise for meter reading of 1.
9. Set MODE to NORMAL.
10. Set FREQUENCY to component to be measured.
11. Rotate RANGE counterclockwise if necessary for an up-scale reading.
12. Set MODE to AFC.
13. Read amplitude of component in percent, setting decimal in accordance with reference setting made in step 7. To read voltage, switch MAX INPUT VOLTAGE back to setting of step 3 and select ABSOLUTE, adjusting RANGE for an up-scale reading.

Figure 3-4. Relative Measurements in Percent



1. Select ABSOLUTE.
2. Set MODE to NORMAL.
3. Select largest component for use as a reference. Set FREQUENCY to that component, changing MAX INPUT VOLTAGE and RANGE as required (Paragraph 3-15).
4. Set MODE to AFC.
5. Switch to RELATIVE.
6. Turn REF ADJUST counterclockwise.
7. Switch MAX INPUT VOLTAGE one step counterclockwise.
8. Turn REF ADJUST clockwise for meter reading of 0 db.
9. Set MODE to NORMAL.
10. Set FREQUENCY to component to be measured.
11. Rotate RANGE counterclockwise if necessary for an up-scale reading.
12. Set MODE to AFC.
13. Subtract RANGE setting of step 3 from that of step 11 and add the difference to meter reading.
14. To read dBm in a 600-ohm system, switch MAX INPUT VOLTAGE one step clockwise and select ABSOLUTE, adjusting RANGE for an on-scale reading. Note indication in range window. Subtract 10 dBm from meter reading for each step to the left of 1 V; add 10 dBm for each step to the right. For example, a meter reading of -3 dB and a range indication of 10 mV reads -43 dBm.

Figure 3-5. Relative Measurements in DB

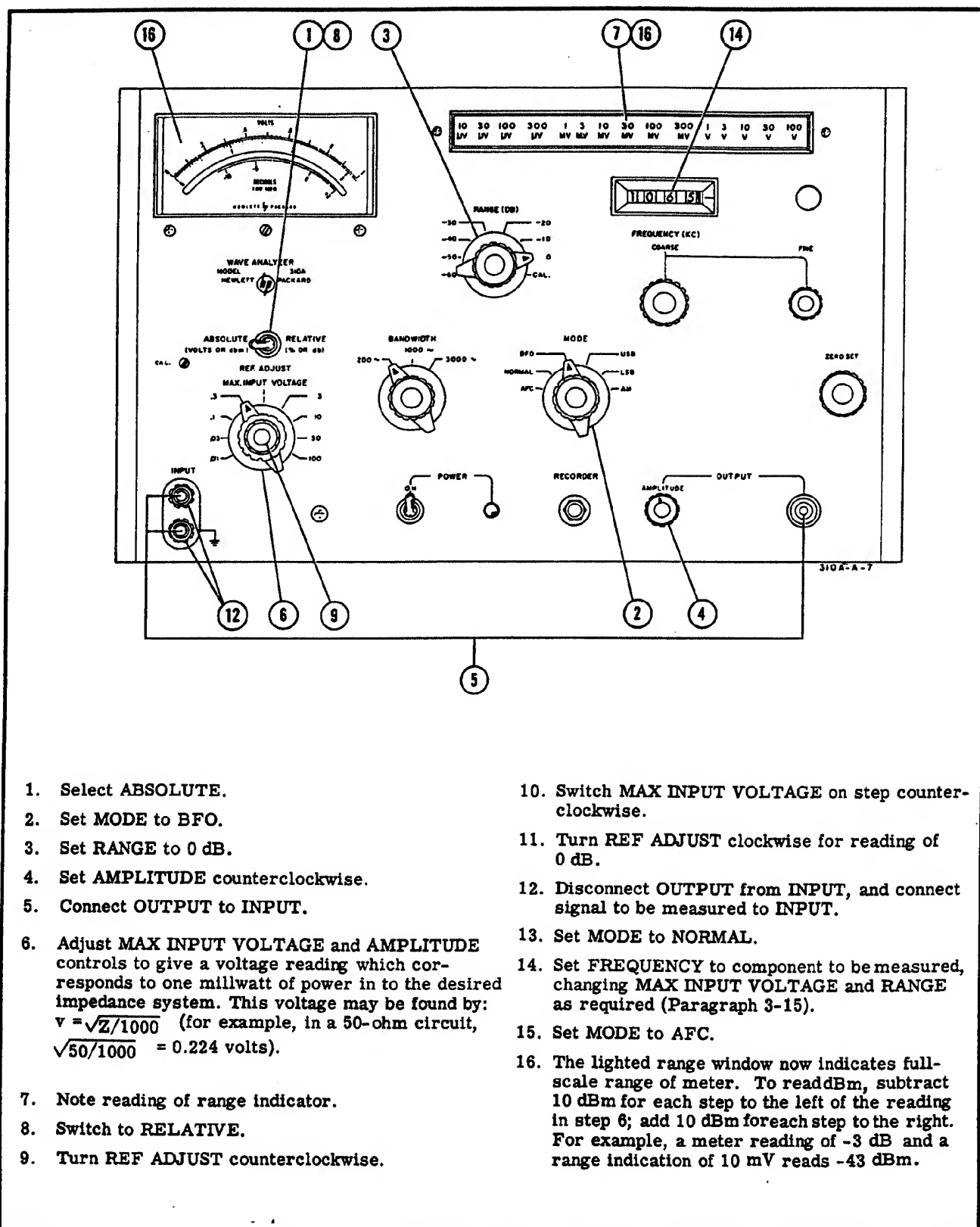
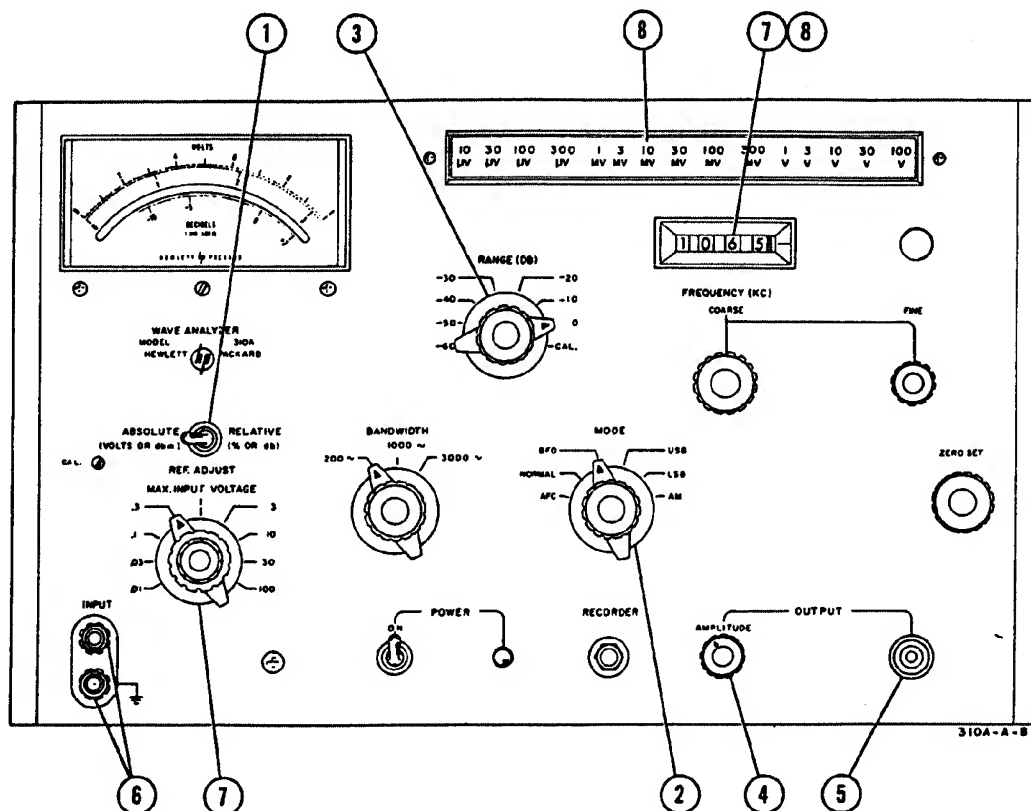
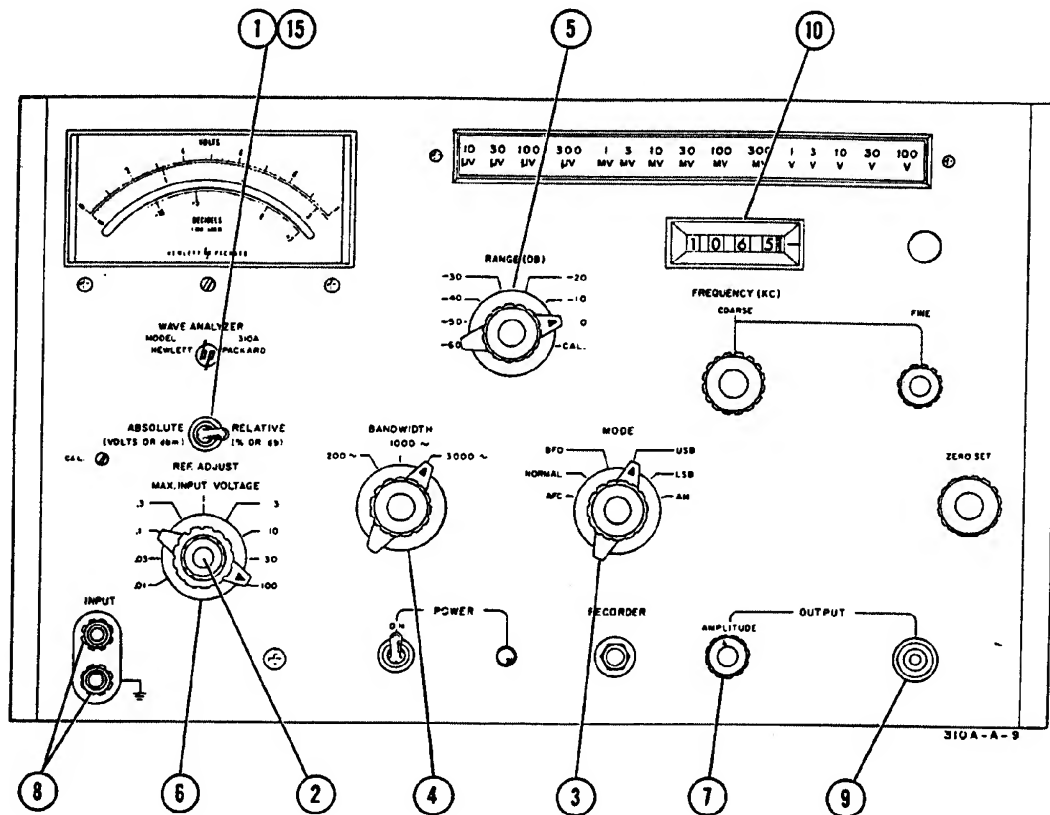


Figure 3-6. Reading DBM At Any Impedance Level



1. Select ABSOLUTE.
2. Set MODE to BFO.
3. Set RANGE to 0 DB.
4. Set AMPLITUDE counterclockwise.
5. Connect circuit to be tested to OUTPUT terminal. Use resistive network to match OUTPUT to input impedance of circuit. OUTPUT impedance is 135 ohms.
6. Connect output of circuit to be tested to INPUT terminal. Terminate circuit with characteristic impedance.
7. Set FREQUENCY to reference value (a point of maximum response), setting MAX INPUT VOLTAGE and AMPLITUDE for a meter reading of 1 (see Paragraph 3-15 for possible overload conditions).
8. Vary FREQUENCY, changing RANGE as required to read relative response. To read response in dB, set MAX INPUT VOLTAGE and AMPLITUDE for a meter reading of 0 DB in step 7. Observe indication in range window for each reading. Subtract 10dB from meter reading for each step to the left of 1 V. For example, a meter reading of -3 dB and a range indication of 10 mV reads 43 dB below reference.

Figure 3-7. Response Measurements



1. Select RELATIVE.
2. Set REF ADJUST to mid-range.
3. Set MODE to USB or LSB or AM.
4. Set BANDWIDTH to 3000 cps.
5. Set RANGE to 0 DB.
6. Set MAX INPUT VOLTAGE to 100.
7. Turn AMPLITUDE full clockwise.
8. Connect signal to INPUT.
9. Monitor OUTPUT with earphones or a audio amplifier.
10. Set FREQUENCY to signal.
11. Set MODE as required (USB, LSB, or AM).
12. Turn RANGE counterclockwise until signal level is satisfactory.
13. If signal level is too low with RANGE set to -60 dB, turn MAX INPUT VOLTAGE counterclockwise until a suitable level is reached.
14. Set OUTPUT signal volume with REF ADJUST.
15. To measure signal level, switch the ABSOLUTE and set MAX INPUT VOLTAGE for an up-scale reading. Keep RANGE at -60 dB unless MAX INPUT VOLTAGE is on 100.

Note: For convenience, signals can be monitored with RANGE set to arbitrary levels. Overloading the input will produce audible distortion, and will increase the apparent bandwidth of the signal.

Figure 3-8. Receiver Modes

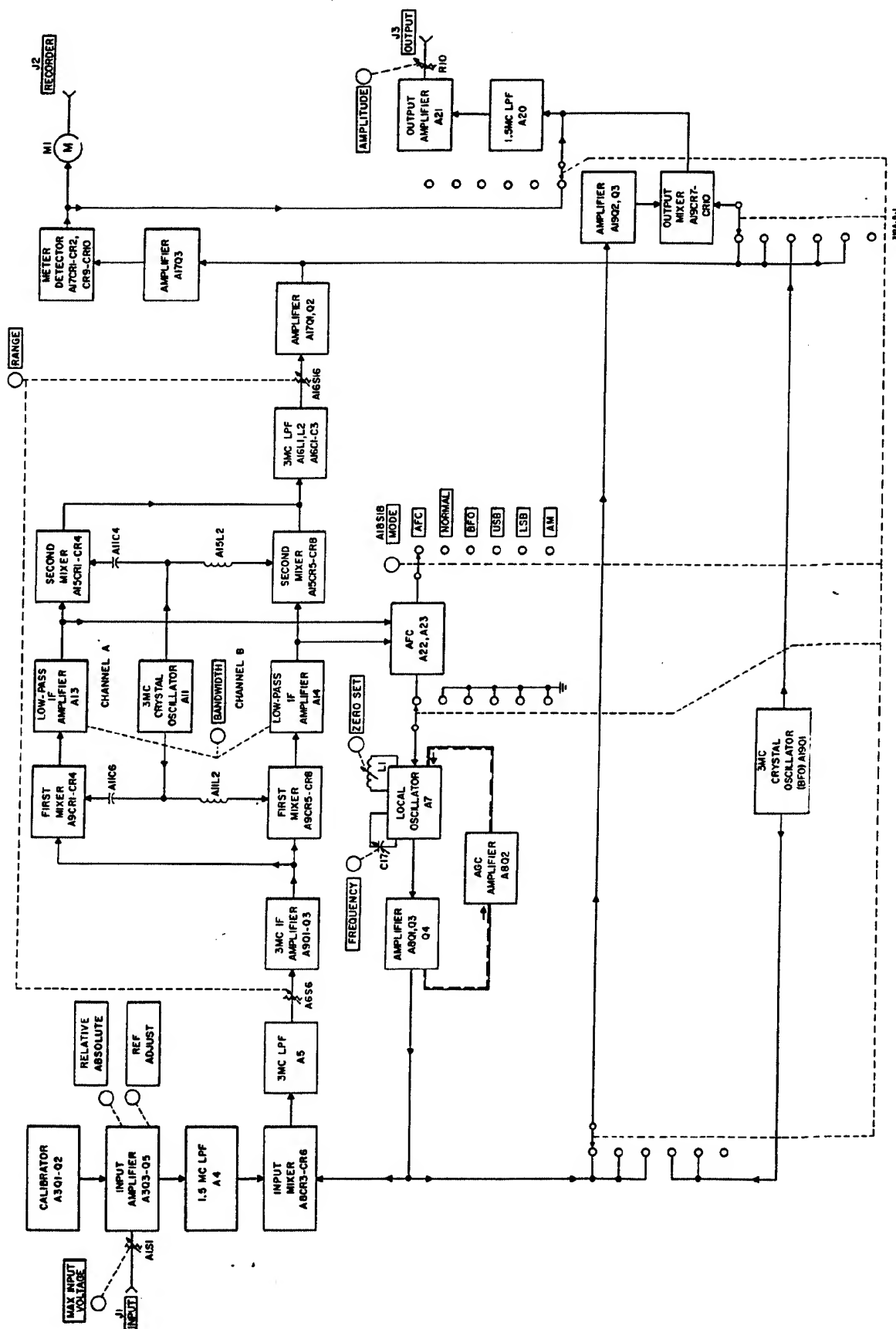


Figure 4-1. Overall Block Diagram

SECTION IV

CIRCUIT DESCRIPTION

4-1. GENERAL.

4-2. The Model 310A Wave Analyzer is a narrow-band AF-RF Voltmeter, tunable to any frequency between 1 kc and 1.5 Mc. Sharp cut-off filtering is accomplished at audio frequencies by a double-heterodyne process. The local Oscillator is above the operating frequency, tunable from 3 to 4.5 Mc. The crystal (BFO) Oscillator, crystal controlled, is at 3 Mc, transferring the components around this frequency to the audio range for filtering and then back again to 3 Mc by a phasing single-sideband technique.

4-3. For single-control tuning without bandswitching, all filters are low-pass. To eliminate unwanted mixer products and extraneous signals, filters are included which cut off at 1.5 Mc, and 3 Mc. The "front end" is essentially "wide open" to all frequencies, therefore an attenuator (MAX INPUT VOLTAGE) is included to attenuate the incoming signal to an acceptable amplitude.

4-4. Accessory circuits include automatic frequency control, a beat-frequency oscillator for carrier insertion and to act as a signal generator, a 100-kc calibrator, regulated power supplies, and a lamp-indicating network to simplify the readout of instrument sensitivity.

4-5. BLOCK DIAGRAM.

4-6. Figure 4-1 shows an overall block diagram of the Model 310A. An examination of the switching functions shown in the block diagram will clarify the various modes of operation. Basically, the signal applied to the INPUT terminals is attenuated to an acceptable level by MAX INPUT VOLTAGE attenuator A1S1, amplified by input amplifier A3Q3-Q4, then filtered by 1.5-Mc low-pass filter (A4) in order to eliminate undesired signals above 1.5 Mc. First local oscillator A7, tunable from 3 to 4.5 Mc, produces a 3-Mc beat-frequency with incoming signals in the 0 to 1.5 Mc range. Other mixer products are attenuated by 3-Mc low-pass filter A5.

4-7. After attenuation and amplification, the signal is delivered to the bandpass filter, where it is heterodyned to audio frequency, filtered, and transferred back again to 3 Mc. Audio signals from the filter, drive the automatic frequency control circuits which control first local oscillator A7. MODE switch A18S18 grounds the automatic frequency control output in all positions except AFC. The filtered 3-Mc signal, attenuated by RANGE attenuator A16 and amplified by meter amplifier A17Q1-Q3, is delivered to the meter detector.

4-8. The meter detector delivers signals to meter M1 and also, in the AM position of the MODE switch, drives output amplifier A21, delivering detected modulation to the OUTPUT connector. In the AFC and NORMAL positions of the MODE switch, the 3-Mc signal from the bandpass filter is applied to the output

mixer, where first local oscillator A7 converts it back to its original frequency. Low-pass filter A20 eliminates residual 3 Mc Oscillator signal and the sum frequency from the mixer. The filtered signal (difference frequency) is then delivered to output amplifier A21 and is available at the OUTPUT connector for monitoring and measurement.

4-9. In the BFO position of the MODE switch, the first local oscillator signal is combined with the output of 3-Mc (BFO) crystal oscillator A19 in the output mixer. This converts the local oscillator signal to the dial frequency, providing a signal at the OUTPUT terminal which is synchronized with the tuned frequency of the instrument. In the USB and LSB positions of the MODE switch, the 3-Mc (BFO) oscillator frequency is altered approximately 1450 cps, low for LSB and high for USB, then fed to the output mixer to demodulate single-sideband signals.

4-10. CIRCUIT DETAILS.

4-11. INPUT ATTENUATOR.

4-12. The input attenuator (Figure 5-15), controlled by MAX INPUT VOLTAGE switch A1S1, is a frequency-compensated resistance-capacitance divider network. This attenuator reduces the input signal level to prevent overloading of the input amplifier. The setting of MAX INPUT VOLTAGE combined with that of RANGE switch A6S6-A16S16 determines the full-scale sensitivity of the Model 310A.

4-13. INPUT AMPLIFIER.

4-14. The input amplifier is a three-stage amplifier with a gain of about 10 dB. About 25 dB of feedback minimizes distortion as long as the input attenuator is set to prevent overdriving the amplifier. Two back-biased diodes, A3CR4 and A3CR5, prevent an overload signal from damaging the circuit. The diodes will conduct on an excessive signal and will limit the drive to the base of A3Q3. The gain of the amplifier is set by CAL adjustment R3, as long as switch S3 is in the ABSOLUTE position. With S3 in the RELATIVE position, input gain may also be adjusted with REF ADJUST control A1R9.

4-15. INPUT MIXER.

4-16. After extraneous signals (images above 6 Mc) are removed by 1.5-Mc low-pass filter A4, the signal, attenuated by resistance network A8R4-R7, is applied to input mixer A8CR3-CR6, where it is mixed with the local oscillator output. The local oscillator is tunable between 3 and 4.5 Mc, therefore difference frequencies can appear between 1.5 and 4.5 Mc, while sum frequencies can appear between 3 and 6 Mc, depending in each case on local oscillator and signal frequencies. The sum frequencies are filtered out by 3-Mc low-pass filter A5. The input mixer is balanced to suppress the local oscillator frequency.

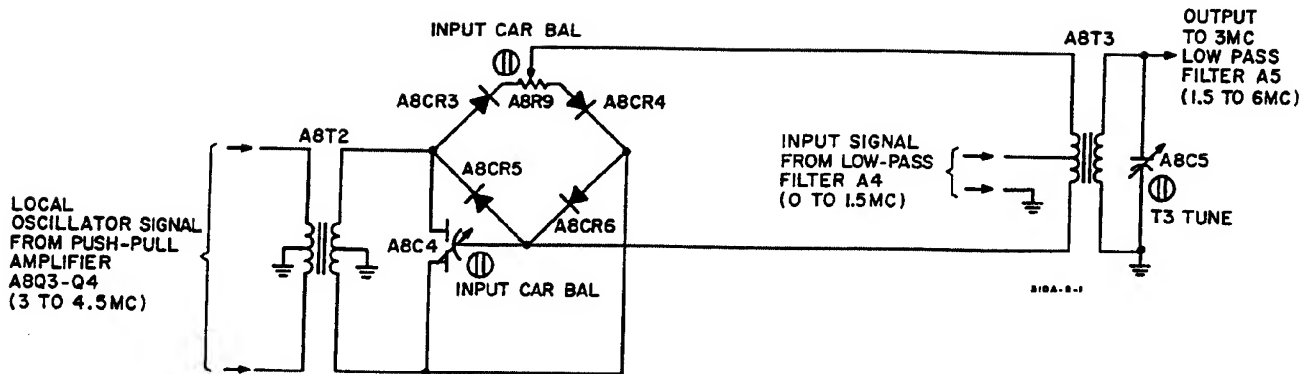


Figure 4-2. Input Mixer

4-17. A simplified schematic of the input mixer is shown in Figure 4-2. The local oscillator signal, applied to the input mixer by the secondary of transformer A8T2, drives the diodes of two adjacent arms of the bridge alternately into conduction. As the diodes conduct, the signal voltage is induced in the secondary of A8T3, with its polarity changed at the rate of the oscillator frequency. Capacitor A8C4 and resistor A8R9 are adjusted to balance out the oscillator voltage. Capacitor A8C5 tunes the secondary of transformer A8T3 to 3 Mc, tending to reject undesired mixer products.

4-18. LOCAL OSCILLATOR.

4-19. The first local Oscillator A7 (Figure 5-15) is basically a Colpitts circuit, generating a frequency between 3 and 4.5 Mc. The variable tuning element is capacitor C17, adjusted by the front-panel FREQUENCY control. Front-panel ZERO SET adjustment L1 sets the local oscillator frequency to 3 Mc when the front-panel indicator reads 0000. Internal adjustments A7C5 (Ratio Adj) sets the oscillator frequency to 4.5 Mc when the front-panel indicator reads 1500 KC. Variable inductor A7L2 allows setting the ZERO SET control to mid-range when the oscillator is properly adjusted. Capacitor A7C4 is a factory-selected part, chosen to properly set the range of A7C5. When the MODE switch is in the AFC position, frequency-control voltage is applied to back-biased diodes A7CR1 and CR2, which acts as voltage sensitive capacitors to modify the frequency of the local oscillator, holding a varying signal within the passband of the Model 310A.

4-20. The output of the first local oscillator is taken from the emitter of A7Q1, amplified by A8Q1, and applied by push-pull common-base amplifier A8Q3-Q4 to the primary of transformer A8T2. The secondary of A8T2 couples the oscillator voltage to input mixer A8CR3-CR6, as explained in Paragraph 4-16. Oscillator output from the secondary of A8T2 is rectified by A8CR2 to maintain a negative charge across A8C10 proportional to the amplitude of the oscillator output. AGC amplifier A8Q2 applies this voltage as bias to the base of oscillator A8Q1, maintaining the oscillator output substantially constant across the tuning range. Oscillator output is also fed from the secondary of

A8T2 to the output mixer (Figure 5-17) when MODE is in AFC, NORMAL, or BFO. The output mixer converts the IF signal back to its original frequency after it has been filtered by the active bandpass filter. In the case of BFO, the 3-Mc beat-frequency oscillator is applied to the output mixer, and the local oscillator signal is converted to the dial FREQUENCY setting.

4-21. ACTIVE LOW-PASS FILTER.

4-22. The low-pass filter provides the 200, 1000, or 3000 cps selectivity of the Model 310A. By phasing techniques, the signal is converted to audio frequency, filtered, and returned to 3 Mc. A block diagram of the filter is shown in Figure 4-3.

4-23. After passing through 3-Mc low-pass filter A5, the signal is delivered to RANGE switch A6 (Figure 5-17), where the amplitude is set to a level appropriate for the following stages. 3-Mc amplifier A9Q1-Q3 then amplifies the signal and applies it to the input transformers of the two filter channels, A9T1 in channel A and A9T3 in channel B. Capacitor A9C7 adjusts the frequency response at the output of the 3-Mc amplifier to produce a symmetrical passband at the output of the active bandpass filter. Capacitors A9C11 and C16 resonate the input transformers of the two channels to 3 Mc.

4-24. The output of 3-Mc crystal oscillator A11Q1 (second local oscillator) amplified by A11Q2-Q3, is shifted 45° by an RC network to channel A and an RL network to channel B. The RC network is the resistance reflected by autotransformer A9T2 and the capacitance of A11C6. The RL network is the resistance reflected by autotransformer A9T4 and the inductance of A11L2. The autotransformers convert the single-ended oscillator signal to a balanced drive to the two mixers, where the 3-Mc oscillator signals are mixed with the input signal. The result is two audio-frequency voltages which are 90° out of phase (higher frequency components are also present). The phase difference between the two channels is adjusted by A9C13 and C18. If the signal is above dial setting, channel B lags channel A. If the signal is below dial setting, B leads A in phase. Capacitor A11C3 is adjusted for an oscillator

frequency of 3 Mc +25 cps. The 25-cycle detuning prevents the 3-Mc BFO signal from falling in the notch in the center of the passband during response measurements (Figure 3-7).

4-25. The output of each mixer is passed through two positive-feedback RC low-pass filters, each including a three-stage high-gain amplifier. The filters have a maximally flat frequency response to nearly their cut-off frequency, beyond which the response drops off at 24 dB per octave. Cut-off is 100, 500, or 1500 cycles per second, depending upon the setting of BANDWIDTH switch A10S10. Therefore, signals 100, 500, or 1500 cycles either side of 3 Mc +25 cps will pass through the filter, resulting in a bandpass of 200, 1000, or 3000 cycles respectively. Signals above and below 3 Mc retain their identity and are later restored to their original frequencies by virtue of the phase relationships between channels. Capacitance coupling between the two sections of the filter limits low-frequency response to approximately one-half cycle, thus creating a notch one cycle wide in the center of the passband (the frequency to which the dial is set).

4-26. The two signals are then applied to the output mixer pair, where they modulate the 3-Mc oscillator output from A15Q1. A 90° phase difference in oscillator voltage is created by capacitor A15C4 and inductor

A15L2 in conjunction with the resistance reflected by transformers A15T1 and T3. The audio signal creates two sidebands in each mixer output, equidistant above and below 3 Mc, but with differing phase characteristics between channels. The signals are combined in transformer A15T2. If the original signal was above 3 Mc, the upper sidebands add and the lower one cancels. If the signal was below 3 Mc, the lower sidebands add and the upper ones cancel. The 3-Mc oscillator signal is suppressed by the balanced mixers.

4-27. AFC CIRCUIT.

4-28. The audio signal from each channel of the active low-pass filter is applied to the input of the AFC circuit. A block diagram of this circuit is shown in Figure 4-4. The complete schematic diagram appears in Figure 5-23. The circuit converts phase and frequency information from the two audio channels to a correction voltage which is applied to two back-biased diodes which act as voltage-sensitive capacitors (A7CR1 and CR2) in the plate circuit of local oscillator A7Q1. The change in capacitance coupled into the oscillator plate circuit by A7T1 modifies the oscillator frequency in such a direction as to bring the signal close to the center of the active filter passband (3 Mc +25 cps).

4-29. The signals from the two audio channels are amplified by A22Q1 and Q3. Channel A output from

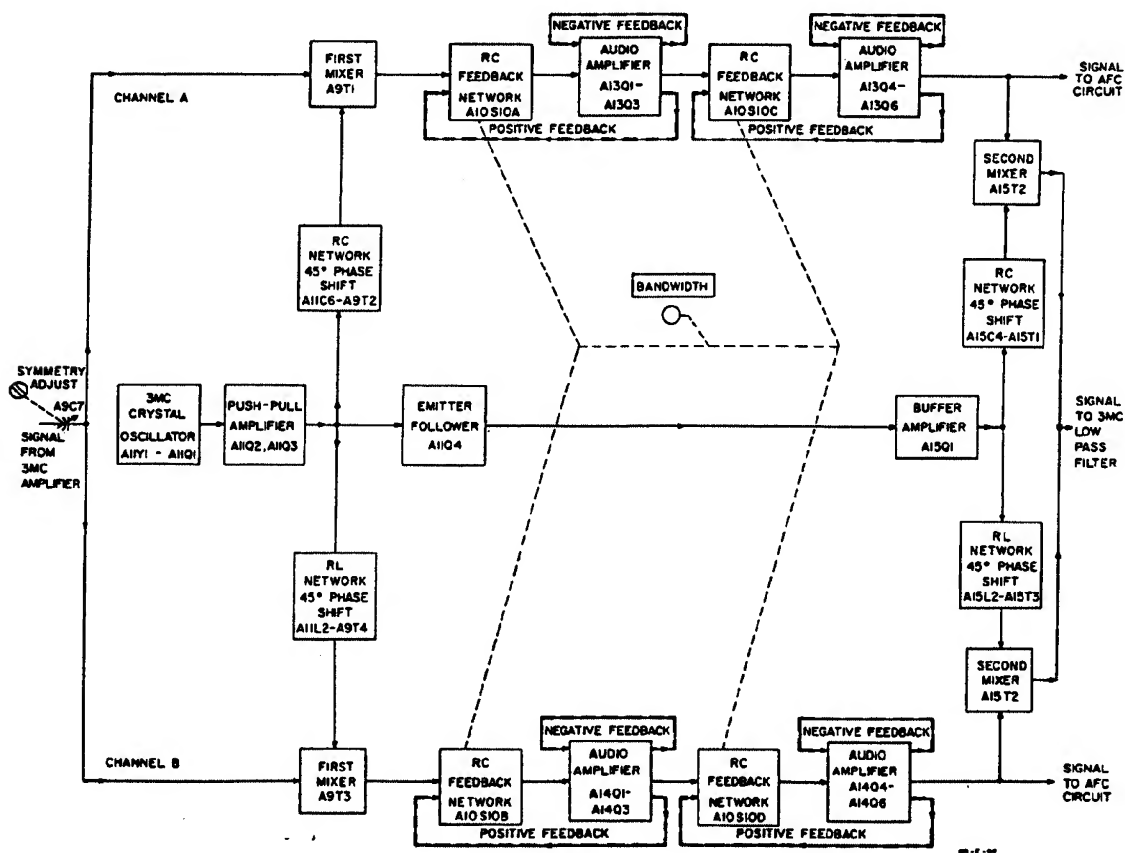


Figure 4-3. Active Low-Pass Filter

A22Q3 is amplified and rectified by AGC amplifier A22Q2, charging capacitor A22C24. When the charge on A22C4 is large enough to turn on diodes A22CR2-CR5, a voltage-driver action takes place between the diodes and resistors A22R5 and R38, reducing the level of the incoming signals.

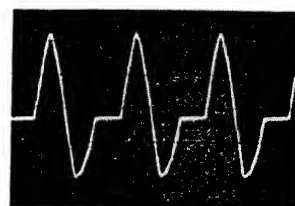
4-30. SCHMITT TRIGGER. The two amplified signals are combined through diodes A22CR7 and CR9. The diodes allow the negative-going half of the channel B signal to pass, and allow the positive-going half of the channel A signal to pass. The result (with the base of A22Q4 disconnected) is illustrated in Figure 4-5. This signal is applied to the base of A22Q4 in the Schmitt trigger circuit. The Schmitt trigger is a rectangular-wave generator with two triggering levels. When the signal moves negative past the lower switching limit, A22Q4 turns off, its collector voltage goes positive, driving A22Q5 into conduction, and feedback between the emitters of the two transistors holds the circuit in this condition until the incoming signal moves positive past the upper switching limit. The resulting output is an unsymmetrical square wave, the positive or negative regions being longer depending upon which channel is leading in phase. The waveform with the base of A22Q4 connected is illustrated in Figure 5-22 (Note: with A22Q4 connected, most of the positive portion of the waveform is clipped by transistor conduction). When channel A is leading (signal below dial setting), the square wave is positive more of the time.

4-31. The output of the Schmitt trigger drives the base of A22Q6. There are two outputs from this stage. The collector output is applied to a positive counter consist-

WAVEFORMS AT JUNCTION OF A22R23 AND A22R24
WITH BASE OF A22Q4 DISCONNECTED



INPUT FREQUENCY
BELOW DIAL READ-
ING (CHANNEL A
SIGNAL LEADING)



INPUT FREQUENCY
ABOVE DIAL READ-
ING (CHANNEL B
SIGNAL LEADING)

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Figure 4-5. Combined Filter Signals

ing of A22C16, A23CR1, CR2, and R1. A22C16 differentiates the square wave. Diodes A23CR1 and CR2 transfer the positive-going pulses to resistor A23R3. The output of the counter, filtered by A23R3 and C2, is proportional to the frequency of the signal from A22Q6. This voltage moves positive when the tuning error increases in either direction.

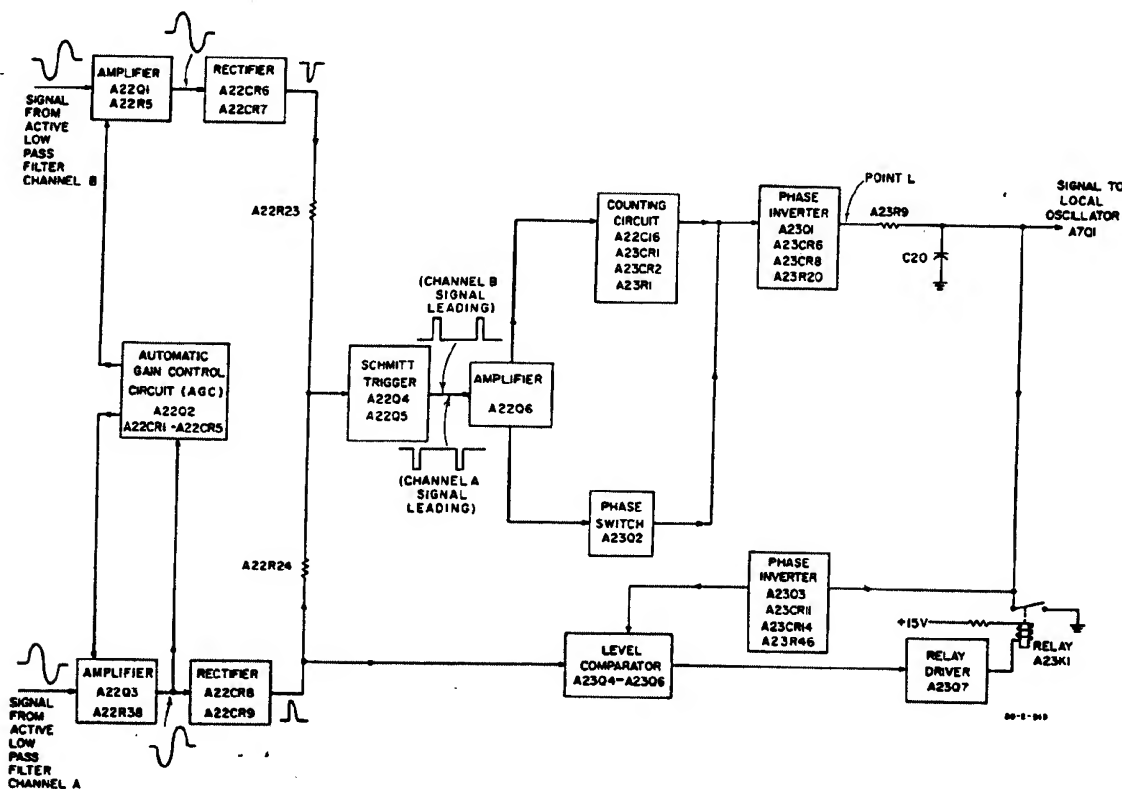


Figure 4-4. Automatic Frequency Control

4-32. The emitter output of amplifier A22Q6, filtered by capacitor A23C5 and resistor A23R15, is positive or negative depending upon the symmetry of the square wave. This dc voltage is amplified by phase switch A23Q2, and applied, along with the counter output, to the base of phase inverter A23Q1.

4-33. **PHASE INVERTER.** The voltage at point L (Figure 5-23) is such that diodes A23CR6, CR7, and CR8 act as switches, taking the amplified counter output from either the collector or the emitter (180° out of phase) of A23Q1, depending upon the bias level delivered by phase switch A23Q2. Thus, the phase switch determines the polarity of the correction voltage, while the counter determines the amplitude. The resulting output is delivered to the local oscillator.

4-34. If a signal is above dial frequency but within the passband of the active low-pass filter, the signal from channel B will lead that from channel A. The square-wave output of Schmitt trigger A22A4-Q5 will then be negative longer than it is positive, and the drive to phase switch A23Q2 will be negative. The phase switch output will be less negative, increasing conduction through phase inverter A23Q1. The collector output switch in the phase inverter circuit, A23CR6-CR7, will turn off, and emitter output switch A23CR8 will turn on, delivering a more positive voltage to voltage-sensitive capacitors A7CR1-CR2 in the local oscillator circuit. This constitutes an increase in the back-bias on these two diodes, decreasing their capacitance, and raising the frequency of the local oscillator. The amplitude of the correction voltage is set by Neg Out control A23R20. As long as the signal is within the passband, the AFC circuit will hold for dial mistuning (or signal drift) up to 3 kc. Beyond this limit, or when the signal measures less than 1/4 scale on the most sensitive range, a disabling circuit grounds the AFC output.

4-35. AFC DISABLING CIRCUIT.

4-36. The circuit of phase inverter A23Q3 is much the same as that of A23Q1. If the output of A23Q1 exceeds the range of -0.5 to +1.0 volt, a positive signal is delivered from either the emitter or the collector of A23Q3 through switches CR12 and CR13, or CR14. This signal turns on A23Q6, turning off A23Q5, and delivering a positive voltage to the base of relay driver A23Q7. The resulting conduction through A23Q7 energizes relay A23K1, shorting the output of the AFC circuit. This allows the signal to drift out of passband of the active filter removing negative bias from the base of A23Q4 and allowing A23Q4 to turn on, holding A23Q5 in the non-conducting state, and therefore holding relay A23K1 closed. The bias for this holding circuit is delivered through A23CR8, filtered by resistor A23R40 and capacitor A23C10. If a signal reappears in the passband, Schmitt trigger A23Q4-Q5 will pass its negative switching limit, turning A23Q4 on, releasing A23K1 and restoring AFC control. Hold-Off Level control A23R27 is adjusted so that the AFC will take control of any signal greater than one-quarter scale on the most sensitive range. Neg-Cut-Off control R46 adjusts phase inverter A23Q3 to deliver cut-off voltage to A23Q6 when the AFC output exceeds the range of -0.5 to 1.0 volt.

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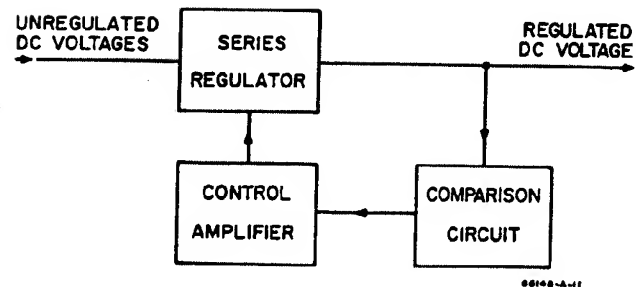


Figure 4-6. Series Regulated Power Supply

4-37. METER AMPLIFIER.

4-38. With RANGE switch A6S6 (Figure 5-17) in positions up to -30 dBm, signals are allowed to pass through the active filter unattenuated. Above that level, they are attenuated before being applied to the input of the filter. The filtered signal is coupled by transformer A15T2 to the input of a 3-Mc low-pass filter A16L1-L (Figure 4-1), then further attenuated in the second section of the RANGE switch, A16S16. After two stages of amplification by A17Q1 and A17Q2, the signal is fed to the front-panel meter M1, and also to output amplifier A21 when MODE switch A18S18 is in the AM position.

4-39. BFO.

4-40. Crystal oscillator A19Q1 provides carrier insertion signal for sideband reception, and also a signal at the tuned frequency for testing purposes. Diodes A19CR1-CR6, in conjunction with MODE switch A18S18 control oscillator functions, and also select the signal fed to output amplifier A21. With MODE in AFC or NORMAL, the oscillator is disabled, and diode A19CR6 is turned on, applying the input signal to the output mixer. In the BFO position, -15 volts is applied to the collector of A19Q1, energizing the oscillator, and A19CR1 and A19CR2 are turned on, grounding the crystal tuning circuits. The diode A19CR5 is turned on, coupling the Oscillator output to the output mixer. In the sideband positions of the MODE switch, A19CR6 is on, allowing the input signal to be applied to the output mixer and oscillator output is coupled through A17R7 to common-base amplifier A19Q2. Diodes A19CR1-CR4 determine whether capacitor A19C7 tunes the crystal (USB) or whether both A19C7 and A19C6 are used (LSB). For USB, the oscillator is tuned approximately 1450 cycles above 3 Mc. For LSB, the frequency is set approximately 1450 cycles low. In the AM position, the oscillator is de-energized, A19CR6 is turned off, and the rectified signal from A17T1 is coupled through the MODE switch to the input of 1.5-Mc filter A20.

4-41. OUTPUT MIXER.

4-42. In the AFC, NORMAL, and BFO positions of the MODE switch, the local oscillator voltage from transformer A8T2 is applied to the balanced input of the output mixer through amplifier A19Q2-Q3. The mixer transfers the 3-Mc signals to their original frequency, and applies them to 1.5-Mc low-pass filter A20. The filter attenuates high-frequency products of the mixer.

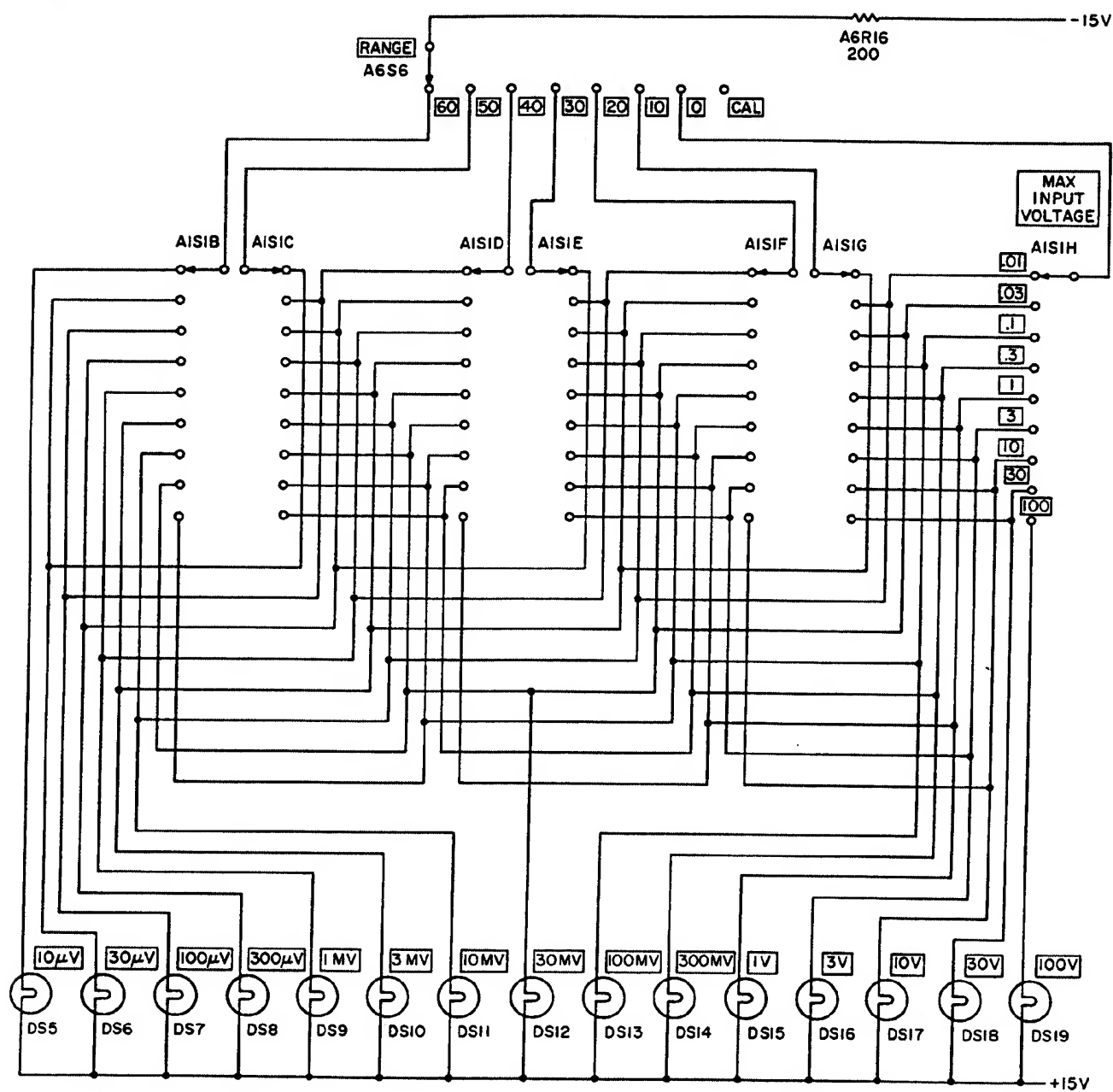


Figure 4-7. Indicator Light Circuit

310A-C-7

The signal is finally amplified by output amplifier A21 before being applied to the OUTPUT terminals.

4-43. POWER SUPPLIES.

4-44. There are two regulated power supplies: + 15- and -15-volt. Both supplies are series-regulated types. The series regulator is connected in series with the main load. The output voltage is monitored and compared to a reference voltage. The voltage differential is applied through a control amplifier to the series regulator. This differential voltage changes the effective resistance of the series regulator which in turn holds the output voltage constant (see Figure 4-6).

4-45. The -15-volt supply is series regulated by Q1 and Q2. The output voltage is sampled at A24R7 and compared to the drop across breakdown diode A24CR4 by control amplifier A24Q2. The amplified error voltage is applied to the base of driver A24Q1, which provides low-impedance drive to series regulator Q2. Breakdown diode A24CR3 provides fixed voltage to

the base of Q1, making this stage a constant-current device which tends to isolate the second regulator from changes in the output of rectifiers A24CR1 and A24CR2. The on-off switch grounds C14 when the power is turned off. The positive 15-volt supply is essentially the same as the negative supply except for polarity.

4-46. INDICATOR CIRCUIT.

4-47. The front-panel range indicator includes lamps DS5 through DS19, illuminating one of 15 voltage-range windows from 10 μ V through 100V. The circuit is illustrated in Figure 4-7. Wiring to the lights is connected through RANGE switch A6S6 and through MAX INPUT VOLTAGE switch A1S1. Each row of contacts on A1S1 represents a position of A6S6, and each row is connected to the light chain one position in advance of the previous. Thus a one-position change in either switch will result in a one-position change on the indicator panel. When the RANGE switch is at 0 DB, the most sensitive range available is 10 mV. When RANGE is at -60 DB, the least sensitive range is 100V.

Table 5-1. Recommended Test Equipment

Item No.	Instrument Type	Critical Specifications	Model
1	AC Voltmeter	Voltage Range: 0.1 mV to 100 V Voltage Accuracy: $\pm 3\%$ of full scale Frequency Range: 1 kc to 1.5 Mc Impedance: 10 megohms	Ⓢ 400H
2	Electronic Counter	Frequency Range: 1 kc to 4.8 Mc Accuracy: ± 1 count \pm time base accuracy Impedance: 10 megohm Sensitivity: 1.0 mV RMS	Ⓢ 5245L with Ⓢ 5261A (plug-in) and Ⓢ 10003A (Voltage Divider Probe)
3	Audio Oscillator	Frequency: 1 to 600 kc Output: 3 V into 50 ohms Output Level: variable	Ⓢ 200S
4	Oscilloscope	Frequency Range: DC to 7.5 Mc Vertical Sensitivity: 0.1-20 V/cm Horizontal Sensitivity: 0.1-2 V/cm Input Impedance: 10 megohm	Ⓢ 175A (Oscilloscope) Ⓢ 1751A (Vertical Ampl.) Ⓢ 10001B/D (10:1 voltage Divider Probe)
5	DC Voltmeter/Ohmmeter	Voltage Range: 1 to 35 Vdc Voltage Accuracy: $\pm 3\%$ Ohmmeter Range: 1 ohm to 100 megohm Ohmmeter Accuracy: $\pm 5\%$	Ⓢ 412A
6	Soldering Iron	Wattage Rating: 50 watts Max Tip Temp: 800°F Tip Size: 1/16" to 3/32" Round Tip Diameter: 3/4"	Ungar #665 Handle #885-3/4" Cup Tip #PL333 Tiplet
7	Precision Attenuator	Attenuation: 90 dB in 10dB steps Accuracy*: ± 0.3 dB to 1 kc Frequency Range: dc to 10 kc Impedance: 50 ohms	Ⓢ 355B/D
8	Resistors	(1) 5.6k ohm $\pm 10\%$ 0.5W	Ⓢ 0687-5621
		(1) 2.7k ohm $\pm 10\%$ 0.5 W	Ⓢ 0687-2721
		(2) 18 ohm $\pm 10\%$ 0.5W	Ⓢ 0687-1801
		(1) 135 ohm $\pm 1\%$ 0.5W	Ⓢ 0727-0466
9	Tuning Screw ADJ (Non-conducting)	Rod (Bakelite or wood): Approx Diameter 1/4" with a screwdriver-type blade at one end and a thin slot at the other	----
10	Channel Filters	Bandpass: 9 to 50 kc Impedance: 600 ohms Rejection: 30 dB	Allison Laboratories Incorporated
		Bandpass: 250 to 672 kc Impedance: 600 ohms Rejection: 30 dB	Model 2C
11	Frequency Response Test Set	Frequency Range: 300 kc-1.5 mc Output: 3V into 50 ohms Adjustable in 10-dB steps by 0 to 70 dB attenuator	Ⓢ 739A

* At 10 kc the attenuator must be calibrated to an accuracy of $\pm 0.5\%$ from 0 to -80 dB.

SECTION V MAINTENANCE

5-1. INTRODUCTION.

5-2. This section provides maintenance and service information for the 310A. The section includes recommended test equipment, performance checks, replacement, repair, adjustment procedures, and troubleshooting charts. If the serial prefix (the first three numbers of the serial number) of your instrument is different than that listed on the title page of this manual, then there are differences between your instrument and the instrument described in this manual (refer to Appendix I).

5-3. TEST EQUIPMENT.

5-4. Table 5-1 lists equipment in number order. Items numbered 1 through 3 are required for performance checks. Items numbered 3 through 6 are required for troubleshooting. Items numbered 1 through 11 are required for adjustment, replacement, and repair procedures. Instruments other than those listed may be used, provided their performance meets the basic requirements listed in Table 5-1.

5-5. PERFORMANCE CHECKS.

5-6. The performance check procedures are used to check the 310A against its specifications. All checks are made from the front panel, thus the instrument panels need not be removed. The procedures are useful as incoming or outgoing quality control, periodic maintenance, or after-repair checks. If the 310A fails any of these checks, refer to Paragraph 5-12 for troubleshooting guides.

5-7. GENERAL CHECK.

a. Check operation of voltage range indicator lamps by switching RANGE and MAX INPUT VOLTAGE controls to all positions except CAL.

b. Check residual meter reading with the 310A set as follows: BFO, -60 dB, 200 cps, 0.01V, and OUTPUT AMPLITUDE fully clockwise. Residual meter reading should be less than 10% of full scale.

c. Check REF ADJUST control with the 310A set to CAL, NORMAL, and RELATIVE. Range of the control should be at least 10 dB.

5-8. SELECTIVITY CHECK.

a. Connect equipment as shown in Figure 5-1.

b. Calibrate 310A (refer to Figure 3-2).

c. Switch MODE to NORMAL and BANDWIDTH to 200. Set oscillator for approximately a 2-volt, 10-kc output signal.

d. Tune 310A FREQUENCY (KC) control for center-frequency (see Note, Figure 3-3).

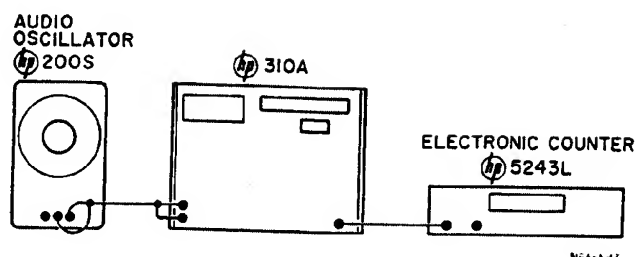


Figure 5-1. Frequency and Sensitivity Check

e. Adjust oscillator output amplitude for full scale 310A meter reading.

f. Increase oscillator frequency until 310A meter reading decreases 3 dB from maximum and record frequency. Decrease oscillator frequency until 310A meter reading decreases 3 dB from maximum record frequency. Specification: The recorded frequency readings must be within 108 cps of the center frequency.

e. Repeat steps c, d, e, and f for the BANDWIDTH settings of 1000 and 3000, respectively. Specifications: For BANDWIDTH settings of 1000, the 3 dB points must be within 540 cps of center frequency for BANDWIDTH setting of 1000 and within 1550 cps of center frequency for BANDWIDTH setting of 3000.

Note

If frequency counter will not trigger then connect to INPUT (in parallel with oscillator).

5-9. BFO AND FREQUENCY CHECK.

a. Connect OUTPUT of 310A to INPUT and setup as follows:

ABSOLUTE-RELATIVE	ABSOLUTE
MAX INPUT VOLTAGE	1
BANDWIDTH	200
MODE	BFO
RANGE	0
FREQUENCY (KC)	0000

b. Adjust AMPLITUDE control near full clockwise and adjust ZERO SET to notch at bandpass center.

c. Disconnect INPUT and connect equipment as shown in Figure 5-1 (the audio oscillator is unnecessary).

d. Check frequency dial accuracy by comparing dial settings with counter readings. Specification: Counter readings should be within $\pm(1\% + 300 \text{ cps})$. If 310A operation is unsatisfactory refer to Table 5-2.

5-10. AFC DISCRIMINATOR CHECK.

- a. Calibrate 310A as shown in Figure 3-2.
- b. Connect instruments as shown in Figure 5-1.

Note

Frequency Counter should be connected in parallel with oscillator.

- c. Set 310A as follows:

MAX INPUT VOLTAGE..... 3
RANGE 0
MODE NORMAL
ABSOLUTE/RELATIVE..... RELATIVE

- d. Set oscillator for an output signal of about 100 kc and tune 310A to input signal.
- e. Adjust REF ADJUST for 2.0 volt and switch MODE to AFC.
- f. Increase oscillator frequency slowly so that AFC circuit automatically returns and tracks input signal frequency. The AFC circuit will eventually lose control causing a sudden drop in the meter reading at this point.
- g. Repeat steps d and e.
- h. Decrease oscillator frequency slowly and record the counter reading at the point that the AFC circuit loses control.
- i. The AFC control range or hold-in range should be ± 3 kc minimum. If AFC operation is unsatisfactory, refer to Table 5-3.

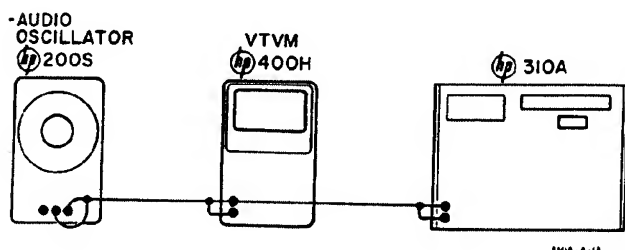


Figure 5-2. Voltage Accuracy Check

5-11. VOLTAGE ACCURACY CHECK.

- a. Connect equipment as shown in Figure 5-2.
- b. Calibrate 310A as shown in Figure 3-2.
- c. Set MODE selector to NORMAL.
- d. Set ABSOLUTE/RELATIVE switch to ABSOLUTE.
- e. FREQUENCY (KC) to 100kc Oscillator frequency.
- f. Switch MODE to AFC.
- g. Compare voltmeter readings to 310A meter readings. Specification: Meter readings should be correct to within an accuracy of $\pm 6\%$ of full scale sensitivity.
- i. If voltage accuracy is not satisfactory refer to Table 5-2 and 5-3 and check instrument operation.

5-12. GENERAL MAINTENANCE.

5-13. The Model 310A includes 18 etched circuit board assemblies, 5 switch assemblies, a mechanical tuner assembly, a meter movement, and a few component parts mounted on the instrument chassis (refer to Figure 5-3 for assembly locations). For access to all component parts, the Model 310A is equipped with removable top and bottom covers. Removal of the top and bottom covers exposes about three quarters of the component parts of the instrument. The remaining component parts are located beneath additional covers which act as shields.

5-14. TROUBLESHOOTING.

5-15. LOCATING TROUBLE.

5-16. Always start locating trouble with a thorough visual inspection for burned-out or loose components, loose connections, or any conditions which suggest a source of trouble. Check the fuse to see that it is not open.

5-17. If trouble cannot be isolated to a bad component by visual inspection, the trouble should be isolated to a circuit section. Isolation to a circuit section can be accomplished by using the waveforms (located opposite each schematic diagram) and/or using the front panel troubleshooting chart, Table 5-2. Troubleshooting charts, Tables 5-3, 5-4, and 5-5, are additional guides to troubleshooting the power supply and the AFC circuitry.

CAUTION

Be careful when measuring transistor or diode forward or reverse resistance. Almost every ohmmeter has a few ranges that supply enough current or voltage to damage a transistor and some diodes. Always measure ohmmeter open-circuit voltage and short-circuit current on every range that you intend to use. For transistors, ohmmeter open-circuit voltage should not exceed 1.5 volts and short-circuit current should not exceed 3mA on the ohmmeter range used. For diodes, refer to Table 6-1, Reference Designation Index, which describes diode breakdown and forward bias voltage characteristics.

5-18. TROUBLESHOOTING CHARTS.

5-19. Troubleshooting charts, Tables 5-2 through 5-5, list symptoms and possible causes of various troubles. For simplification, only major components are referenced in the troubleshooting charts, but it should be remembered that associated components are also failure possibilities. When testing the wave analyzer it is recommended that line voltage be applied through a variable transformer, and that the transformer be adjusted to deliver a voltage at the low end of the rated 103- to 127-volt range (207- to 253-volt for 230-volt operation). An instrument in good condition should operate satisfactorily from any line voltage within the rated range, but where there is marginal operation, weaknesses become easier to trace at low line voltages.

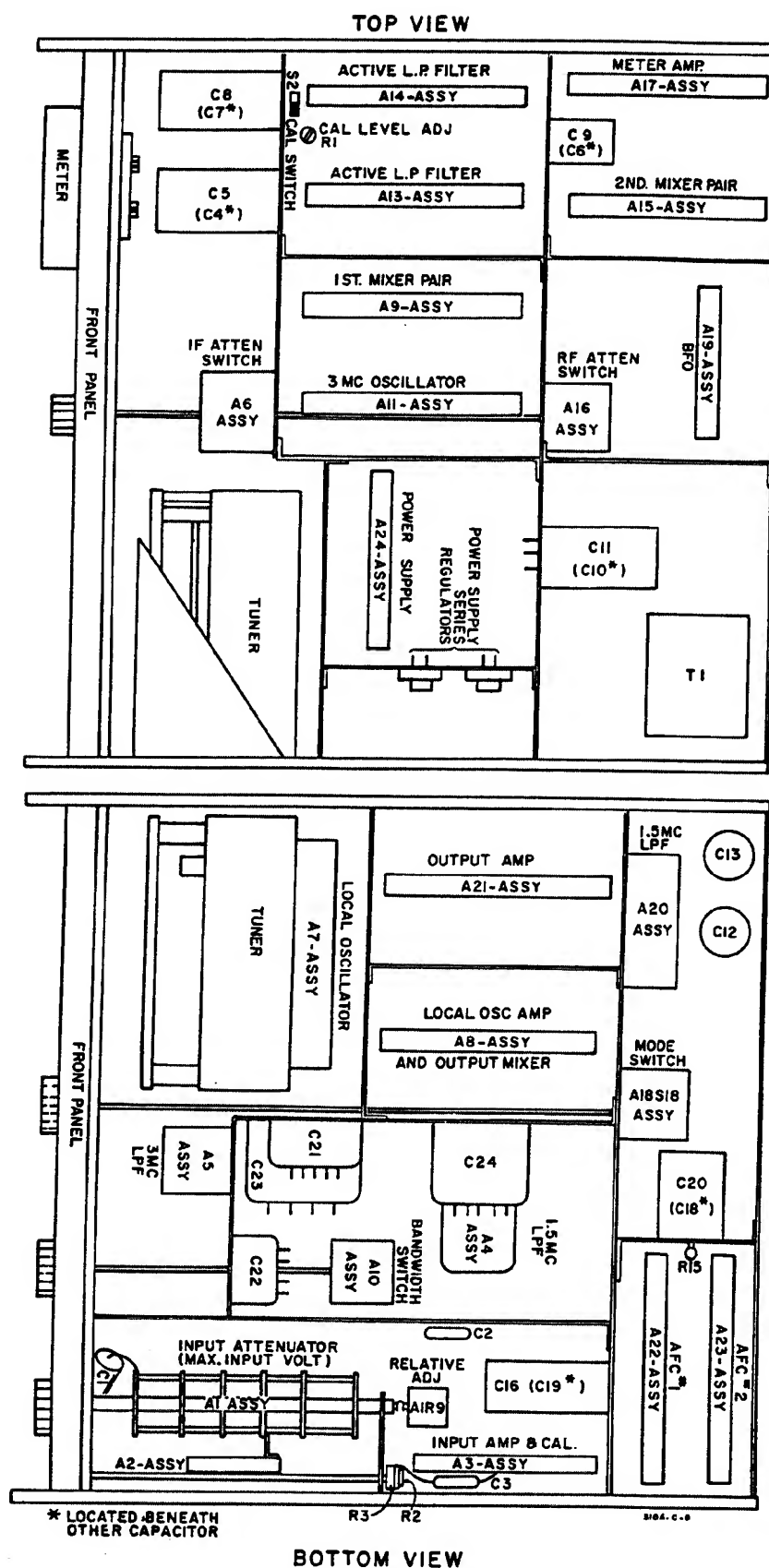


Figure 5-3. Assembly Location

Table 5-2, Front Panel Troubleshooting

Test Equipment and Connections	Important Control Settings (310A)	Indication	Conclusion
- - -	<u>RANGE INDICATOR LAMPS</u> RANGE and MAX INPUT VOLTAGE controls to positions, except CAL	Lamps dim, unlit, or brighter than normal	Power Supply Voltages: low, high, or out Indicator lamp defective
- - -	<u>RESIDUAL METER READING</u> BFO, 200 cps, 0.01V, -60 DB, OUTPUT AMPLITUDE full CW	With no input meter reading more than 20% of full scale	Position of leads on MODE switch (A18S18) causing regeneration, push around and re-check
- - -	<u>REF ADJUST CONTROL</u> CAL, NORMAL, 3000 cps RELATIVE, tuned for maximum meter indication	REF ADJUST does not vary meter reading at least 10dB	Loss of Gain in Input Amplifier A3Q3, A3Q4, or A3Q5
- - -	<u>ZERO SET CONTROL</u> NORMAL, 200 cps, 1V, 0000, -20DB	ZERO SET tunes meter indication to full scale reading	Carrier balance out-of-adjust, (A8 Assembly)
200S and Calibrated 355B/D, connected to INPUT. Input 10kc signal varied in 10-dB steps from -60 to -10 dB	<u>INPUT ATTENUATOR CHECK</u> AFC, 1000 cps, 1V, tuned to input signal, MAXIMUM INPUT VOLTAGE switch varied from 0.3 to 100 (each step is a 10-dB step).	Meter reading must be set to a near-full-scale reference. For every 10-dB increase in input signal, switch MAX INPUT VOLTAGE switch one step higher. If meter reading error is greater than $\pm 2\%$ of full scale of reference setting	MAX INPUT VOLTAGE switch ground leads touching RANGE switch ground leads touching on switch. Bad resistors in MAX INPUT VOLTAGE switch
739A connected to INPUT. Input 1 Mc signal varied from .003 to 1.0			
200S and Calibrated 355B/D connected to INPUT	<u>AFC INPUT AMPLITUDE SENSITIVITY</u> AFC, 1V, ODB, 3000 CPS tuned to input signal	If AFC circuit does not lock on to an input signal amplitude of 0.3 volts	AFC #2 circuit out of adjust A23Q4 defective A23Q5 defective
200S and 5243L/5261A connected to INPUT	<u>AFC FREQUENCY RANGE</u> AFC, 1V, ODB, 1000 cps, tuned to input signal	If AFC circuit does not remain locked to input signal when input frequency is varied at a very slow rate within ± 3 kc of tuned frequency	AFC #1 circuit out of adjust AFC #2 circuit out of adjust A23Q4 defective 2nd Mixer Pair (A15) circuit out of adjust
200S connected to INPUT 5243L/5261A connected to OUTPUT	<u>OUTPUT PHASING</u> NORMAL, 3V, ODB, 1000 cps, tuned to input signal	If OUTPUT frequency changes when 310A FREQUENCY (KC) control is varied within selected BANDWIDTH	IF AMPLIFIER (A9) out of adjust 2nd MIXER PAIR (A15) out of adjust

Table 5-2. Front Panel Troubleshooting (Cont'd)

Test Equipment and Connections	Important Control Settings (310A)	Indication	Conclusion
	<u>BANDWIDTH FLATNESS</u> CAL, NORMAL, 1V, ODB	Tune through 100-kc calibrate signal and observe meter indication of peaks to either side of center frequency. If the amplitude of these two peaks is not the same	A9C7 is out of adjustment
200S and 5245L connected to INPUT	<u>BANDWIDTH SELECTIVITY</u> NORMAL, 3V, tuned to 10-kc input signal, check performed for all bandwidths	Vary input frequency to each side of tuned frequency and record 5245L reading when 310A meter reads 3, 50, and 75 dB below original reference. If limits are not within specifications	Trouble location A3 Assembly, A8 Assembly, A9 Assembly, A15 Assembly
200S and 5245L connected to INPUT (1 kc to 600 kc) 739A and 5245L connected to INPUT (600 kc to 1 Mc)	<u>TUNER TRACKING</u> NORMAL, 1000 cps, 3V, tuned to input signal	If FREQUENCY (KC) dial readings do not agree with 5245L Counter readings within $\pm(1\% + 300 \text{ cps})$	Tuner assembly out of adjust
200S and BANDPASS FILTER (a) with 30dB attenuation at 500 kc, then (b) with 30 dB at 25 kc.	<u>DISTORTION</u> NORMAL, ODB, 200 cps, RELATIVE, tuned to input signal, Meter reference of 0 DB	Tune 310A to second and third harmonic of input signal (for 500-kc input signal tune to second harmonic only). Allow 310A to settle down to each new tuning and assume trouble if harmonics are not less than 80dB down from reference set at input frequency	UNBALANCE OR DISTORTION in A8 Assembly, A9 Assembly, A3 Assembly, or A15 Assembly
AC VOLTMETER connected to OUTPUT	<u>BFO OUTPUT AMPLITUDE</u> BFO, 1000 cps, 1V, OUTPUT AMPLITUDE fully clockwise	Output level less than at least 1.0V RMS	A19R5 out of adjust A19C17 out of adjust
a. AC VOLTMETER connected to 135-ohm resistor connected across OUTPUT b. AC VOLTMETER connected to OUTPUT (135 ohm-resistor removed) c. SAME AS Step b.	<u>RECOVERED FREQUENCY OUTPUT AMPLITUDE</u> a. NORMAL, CAL, ABSOLUTE, 3000 cps, OUTPUT AMPLITUDE fully clockwise b. LSB, CAL, ABSOLUTE, 3000 cps, OUTPUT AMPLITUDE fully CW, tuned for max meter indication c. Same as step b, except MODE to USB	a. Output not at least 0.25 V RMS b. Output not at least 0.53 V RMS c. Same as step b	a. A17R10 out of adjust b. A19C6 & C7 out of adjust c. A19C7 out of adjust

Table 5-3. AFC Troubleshooting

Symptom	Procedure	Indication	Conclusion
AFC will not lock properly. Meter reads about 2/3 normal	1. Check output in NORMAL and AFC.	Output is DSBSC.* Meter sweep in AFC	Channel B of Low-Pass Filter is defective
		Output DSBSC.* Meter does not sweep	Channel A of Low-Pass Filter is defective
AFC will not lock. Meter reads 1 volt in AFC	1. Check dc at Pin 12 of A23	Voltage changes negative Voltage changes positive	Defective A22Q1, A23Q1 short, A22Q4 open, A22Q5 short, A22Q6 short A22Q4 short, A22Q5 open, A22Q1 bad, A22Q6 open, A23Q1 open
AFC will lock on one side only. Meter reads 1 volt.	Check waveform at test point K in AFC	Frequency of rect. waveform sweeps when 310A tuned to one side but not other of input signal	Defective phase switch A23Q2
AFC will not lock. Relay A23K1 chatters in AFC	1. Check operation in NORMAL	Sensitivity reduced in NORMAL. Frequency calibration off	A7CR1 or A7CR2 shorted
AFC will lock on one side only. Meter reading greatly reduced	1. Check for slow meter drift when dial frequency is higher than input frequency	Meter reading will increase until A23K1 energizes. Meter reading will drop and then increase again	A7CR1 or A7CR2 open
AFC will not lock. A23K1 energized continuously	1. Switch to NORMAL	Operation same as in AFC	Defective A22Q2, A23Q4 short, A23Q5 open, A23Q7 short A23K1 short
AFC will not lock. Sensitivity ok.	1. Operation ok in NORMAL	1. In AFC, 310A appears to search.	Defective A22Q1
NOTE: * Double sideband suppressed carrier: Output looks like a full wave signal.			

Table 5-4. -15 Volt Supply Troubleshooting

Symptom	Procedure	Indication	Conclusion
High Output Voltage	1. Disconnect base of Q1	Output drops Output same	Q1 ok Q1 shorted
	2. Reconnect base of Q1. Measure voltage across A24CR3.	Approximately 22.6V. More than approximately 22.6V	A24CR3 ok A24CR3 open
	3. Disconnect base of Q2	Output drops Output same	Q2 ok
	4. Reconnect base Q2. Short emitter to base A24Q1	Output drops Output same	A24Q1 ok A24Q1 shorted
	5. Measure voltage across A24CR4	Approximately 6.8V More than approximately 6.8V	A24CR4 ok A24CR4 open
	6. Adjust A24R7 so base of A24Q2 goes more negative	Output remains high	A24Q2 open

Table 5-4. -15 Volt Supply Troubleshooting (Cont'd)

Sumptom	Procedure	Indication	Conclusion
Low Output Voltage	1. Measure voltage across A24CR3	Approximately 22.6V Less than approximately 22.6V	A24CR3 ok A24CR3 shorted
	2. Parallel A24R1 with 2.7k resistor	Output rises at emitter Q1 Output same as at emitter of Q1	Q1 ok Q1 open
	3. Short emitter to collector A24Q1	Output rises Output same	Q2 ok Q2 open
	4. Parallel A24R2 with 5.6k resistor	Output rises Output same	A24Q1 ok A24Q1 open
	5. Measure voltage across A24CR4	Approximately 6.8V Less than approximately 6.8V	A24CR4 ok A24CR4 shorted
	6. Measure voltage at collector of A24Q2	Approximately 6.8V (same as A24CR4)	A24Q2 shorted

Table 5-5. +15 Volt Supply Troubleshooting

Symptom	Procedure	Indication	Conclusion
High Output Voltage	1. Disconnect base of Q3	Output drops Output same	Q3 ok Q3 shorted
	2. Reconnect base of Q3 Measure voltage across A24CR13	Approximately 22.6V More than approximately 22.6V	A24CR13 ok A24CR13 open
	3. Disconnect base of Q4	Output drops Output same	Q4 ok Q4 shorted
	4. Reconnect base of Q4 Short emitter to base A24Q11	Output drops Output same	A24Q11 ok A24Q11 shorted
	5. Measure voltage across A24CR14	Approximately 6.8V More than approximately 6.8V	A24CR14 ok A24CR14 open
	6. Adjust A24R7 to base of A24Q12 goes more negative	Output remains high	A24Q12 open
Low Output Voltage	1. Measure voltage across A24CR13	Approximately 22.6V Less than approximately 22.6V	A24CR13 ok A24CR13 shorted
	2. Parallel A24R11 with 2.7k resistor	Output at emitter Q3 rises Output at emitter Q3 same	Q3 ok Q3 open
	3. Short emitter to collector A24Q11	Output rises Output same	Q4 ok Q4 open
	4. Parallel A24R12 with 5.6k resistor	Output rises Output same	A24Q11 or A24Q11 open
	5. Measure voltage across A24CR14	Approximately 6.8V Less than approximately 6.8V	A24CR14 ok A24CR14 shorted
	6. Measure voltage at collector of A24Q12	Approximately 6.8V (same as A24CR14)	A24Q12 shorted

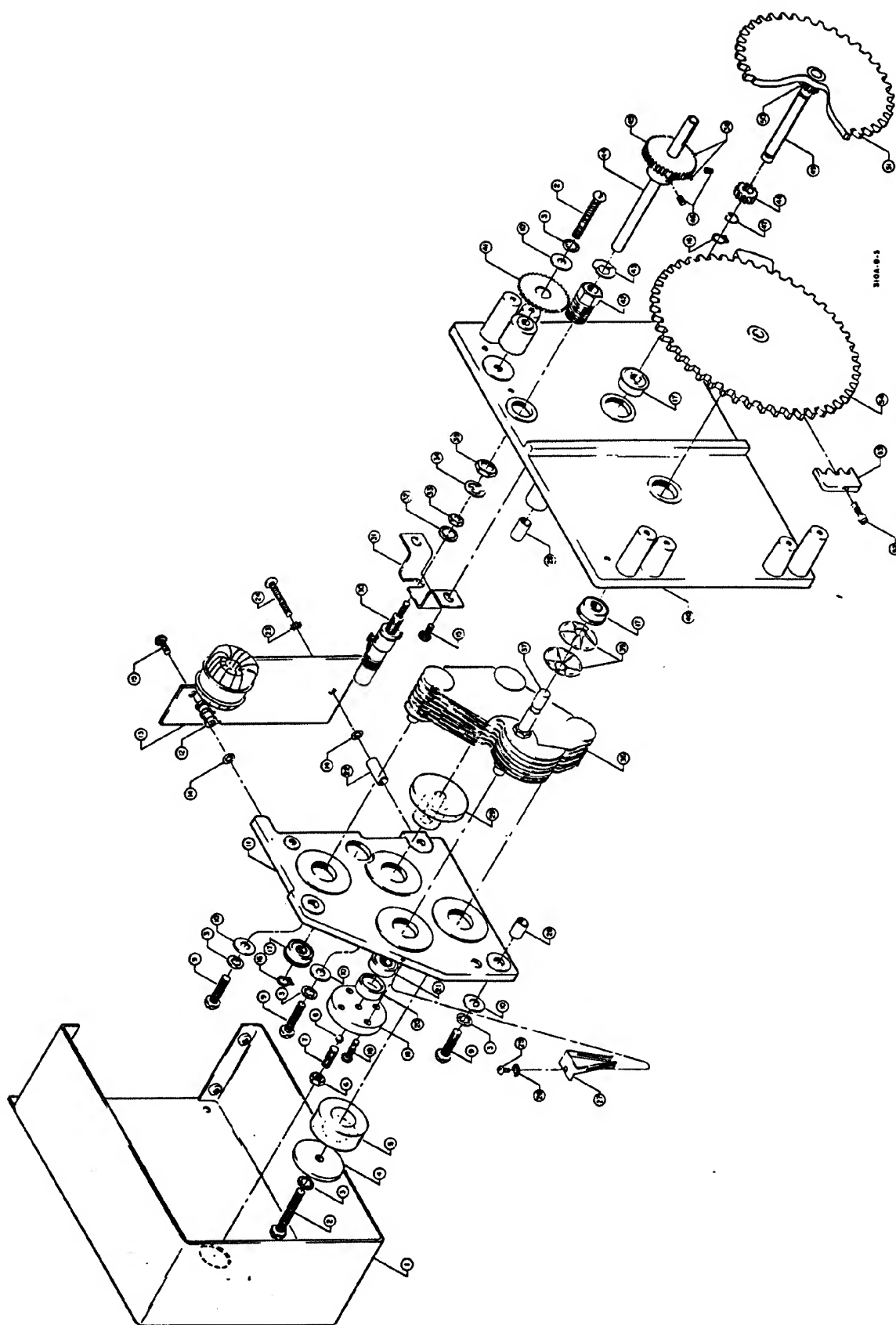


Figure 5-4. Capacitor Tuning Assembly

5-20. REPAIR.**5-21. COVER REMOVAL.**

5-22. To remove top or bottom cover merely remove the four #6-32 flathead machine screws from the cover and slide back and off instrument. To remove side covers merely remove retaining screws.

5-23. CIRCUIT BOARD REPAIR.

5-24. The Model 310A uses 13 easily removable plug-in circuit boards and 5 non-plug-in circuit boards (note that these 18 boards are outlined on the schematics and the area within the outline is light grey). To remove a plug-in circuit board, grasp the edge opposite the plug-in and pull with a very slight side movement. To remove the non-plug-in circuit boards, remove the retaining screws and unsolder lead connections to the board. The board stock number appears on the board, and the stock number and assembly number (A3, A8, etc.) are silkscreened on the interior metal deck to identify the circuit on a particular board. This assembly number must be added to the component designation (A3R3, A8C1, etc.) when referring to Section VI for parts replacement information.

5-25. The circuit boards used in the Model 310A are etched, plated-through type consisting of a base board and conductor. The conductor material is plated to the wall of the holes, thus the holes are effectively extended through the board. This type of board can be soldered from either side of the board. When working on these boards, use a low heat, small tip, soldering iron and a small diameter rosin core solder. Components may be removed by placing the soldering iron on the component lead on either side of the board, and pulling up on the lead. If the component is obviously damaged or faulty, clip the leads close to the component and then remove the leads. Excessive or prolonged heat can lift the circuit from the board or cause damage to components. The component lead hole should be cleaned before inserting a new lead. To remove components having multiple connections, such as potentiometers, transformers, etc., use a special tip. Refer to Table 5-1 for type of soldering tip required.

5-26. INDICATOR LIGHT REPLACEMENT.

5-27. Individual lights in the front panel illuminated indicator may be easily replaced when defective. With the power switch off, remove instrument top cover and the front panel screws at end of section of lights. This will allow the plate with the numbers and letters to slide up far enough to expose the light bulbs. Using a heavy gauge wire, such as lead wire on a large capacitor, push light bulb from center rear of socket until it is loose in socket, then remove and replace.

5-28. TUNING ASSEMBLY REPAIR.

5-29. Under normal operating conditions the tuning assembly should not require maintenance. Shaft bearings are lubricated for the life of the instrument. The following procedures should be followed if replacement of tuning assembly parts becomes necessary. The tuning assembly is three assemblies in one: the LOCAL OSCILLATOR (A7 Assembly) circuit board,

the frequency counter drive assembly, and the capacitor tuning assembly. A sketch of the tuning assembly is shown in Figure 5-7. An exploded view of the capacitor tuning assembly and the local oscillator assembly is shown in Figure 5-4. An exploded view of the frequency counter drive assembly is shown in Figure 5-8. Special tool, Ⓢ Stock No. T9138 alignment tool, is required for rotor adjustment. In addition, a hand press and plastic-head hammer is required since all bearings (except the ZERO SET shaft) are pressed into casting plates. Tables 5-6 and 5-7 list parts.

5-30. REMOVAL OF ASSEMBLY.

- a. Remove bottom, top, and both side covers.
- b. Remove LOCAL OSCILLATOR (A7 Assembly) shield cover (see Figure 5-7). Unsolder leads connected to component side of board (yellow, violet, and two shielded, two conductor, leads).
- c. Remove all front panel knobs.
- d. To remove tuning assembly from instrument, the front panel and right side frame must be partially removed from instrument.

CAUTION

When removing front panel and right side frame, use care not to damage instrument component parts or switch shafts.

- e. When right side frame is removed sufficiently from instrument, unscrew the four tuning assembly retaining screws and remove assembly from right side frame.

Note

Before proceeding with further disassembly, determine the necessary steps from inspection of the Tuning Assembly and Figure 5-4 and 5-8.

5-31. ROTOR (STATOR) REPAIR.

- a. Refer to Figure 5-4.
- b. Disassemble reduction gear shaft (49) from rear casting (11).
- c. Disassemble main gear (54) from rotor shaft (37).
- d. Disconnect A7-Assembly (13) and clip spring (27) from rear casting (11).
- e. Disconnect blue lead from A7-Assembly (13) to insulator stator (4).
- f. Remove three round head screws (2) holding rear casting (11) to front casting (40).
- g. Tilt tuning assembly with rear casting facing upwards (provide clearance for rotor shaft).

CAUTION

Keep clear of ZERO SET coil (30).

- h. Carefully separate rear casting from front casting WITHOUT applying any twisting torque that might damage the stator or rotor.

- i. Remove two centering pivots (28).
- j. Disassemble the rest of the assembly as necessary, and replace any damaged parts.
- k. During reassembly, mount rotor adjusting plate (19), and set rotor centering adjustment screw (7) so that rotor blades clear stator blades while pressing rotor shaft by hand against rotor adjusting plate (19). This is a preliminary adjustment (see Paragraph 5-34).
- m. Reassembly is the reverse of disassembly. Rotate rotor fully clockwise and secure rotor position with masking tape across stator blades to prevent damage during reassembly.

5-32. ZERO SET ASSEMBLY REPAIR.

5-33. Zero set coil L1 (30) can be replaced without disengaging the zero set drive. If gears disengage, the proper relationship can be re-established as indicated in step b of Paragraph 5-33.

- a. Unsolder white lead and grey lead from coil (refer to Figure 5-5).
- b. Turn zero set shaft full clockwise (until stopped by gear stop). Secure this gear position by placing a piece of masking tape across the two gears.
- c. Remove E-shaped retaining ring (B).
- d. Remove coil bracket from casting.
- e. Replace damaged coil.
- f. Mount replacement coil in bracket.

Note: Insert coil fully into opening of bracket before tightening locking nut. See Figure 5-5.

- g. Turn coil slug until spiral pin extends approximately 1/4 inch from coil bushing.
- h. Insert coil shaft into zero set shaft. Spiral pin should clear the brass bushing surface by approximately 1/64 inch, with coil bracket held tightly against casting. If clearance differs greatly from 1/64 inch, turn coil shaft 1/2 turn clockwise or counterclockwise.
- i. Mount coil bracket to casting.
- j. Insert E-shaped retaining ring (B).
- k. Remove masking tape from zero set gear assembly and turn zero set shaft to its counterclockwise stop. While turning zero set shaft, check mechanical alignment of coil shaft. Check correct number of turns between the two mechanical stops (about 11-1/2 turns).

Note

Check that both stops are positively controlled by the gear drive stops and not by the coil slug. If necessary repeat steps g through k.

- m. Reconnect white and gray leads to coil as shown in Figure 5-5.

5-34. TUNING ASSEMBLY MECHANICAL ALIGNMENT.

- a. Loosen set screws holding main gear to main gear shaft.

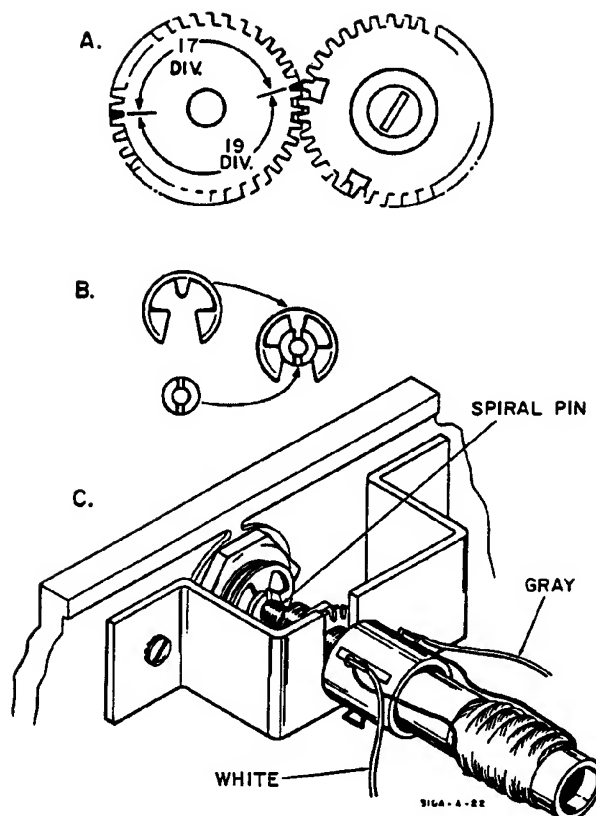


Figure 5-5. Zero Set Assembly

- b. Turn gear assembly against clockwise stop. Set frequency counter at 9950 and tighten one set screw in each counter drive miter gear. Next, turn gear assembly against counter-clockwise stop. Counter should now read 1550 +.5, -0. If necessary, reset counter at high end to read 1550 and go back to low end to check for 9950 -.5, +0. reading. When counter has been set correctly, tighten all set screws in miter gears (items number 15 and 12 Figure 5-8).
- c. Check alignment of miter gears. The two miter gears must run together as smoothly as possible with a minimum of noise.
- d. Set frequency counter to read 1490. Insert alignment tool (Ⓢ Stock No. T9138) into the .281-inch-diameter holes of the two castings. Remove tape from rotor and rotate rotor until the flat edge of the plates rests gently against the alignment tool. Refer to Figure 5-6.
- e. Holding rotor against tool with counter at 1490, tighten set screws in main gear.
- f. Assemble shield (1 - Figure 5-4) to tuner.

5-35. TUNING ASSEMBLY ELECTRICAL TUNING.

5-36. The pre-installation tuning consists of centering the rotor with respect to the stator, adjusting L1 for the correct range of ZERO SET and aligning the assembly for the correct frequency range. Refer to Figure 5-7 throughout procedure.

a. Connect a lead or a short as described to the following points on the circuit board that is part of the tuning assembly:

- (1) Connect a lead to point labeled YEL.
- (2) Connect a lead to point labeled VIO.
- (3) Connect a short between point labeled TO AFC and point beside this point which is labeled with a ground symbol.
- (4) Connect a shielded two-conductor coaxial cable, one lead to point labeled OUT and one lead to point beside OUT which is labeled with ground symbol.

b. Place A7 shield cover in place with three leads passing through cover as shown in Figure 5-7.

c. With 310A turned off, make the following clip-lead connections:

- (1) YEL lead to yellow lead which normally connects to tuning assembly circuit board.
- (2) VIO lead to violet lead which normally connects to circuit board.
- (3) Center conductor of shielded lead to shielded lead from pin 14 of A8.
- (4) Shield of shielded lead to shield of shielded lead from pin 14 of A8.

d. Connect dc voltmeter positive lead to yellow lead. Connect meter common lead to chassis ground.

e. Connect vertical input of oscilloscope to test point B of A8 with X10 voltage divider probe.

f. Adjust A7C5 to mid-range.

g. Turn 310A on. Oscilloscope presentation should be a sine wave whose peak-to-peak amplitude is approximately 65 to 70 mV.

h. Disconnect X10 voltage divider probe from oscilloscope and connect it to frequency counter. Set frequency dial to 0000.

i. Remove plug button and adjust for maximum counter reading with set screw. TIGHTEN lock nut: frequency counter reading must remain approximately maximum.

j. Replace plug button. Turn L1 adjust from one stop to the other and adjust for mid-frequency reading. This should be about 5-1/2 turns from either stop.

k. Using non-conducting tool with slot in end (refer to item no. 9, Table 5-1) adjust A7L2 for Frequency Counter reading of 3000000 ± 100 cps.

m. Turn frequency dial to 1500.

n. Note difference between frequency counter reading and 4500000 cps. If frequency counter reading is high, adjust A7C5 (with non-conducting tool) for a frequency counter reading which is equal to 4500000 - 0.8 times (the difference between 4500000 and the frequency counter reading). If the frequency counter reading is low, adjust A7C5 for a frequency counter reading which is equal to 4500000 + 0.8 times (the difference between 4500000 and the frequency counter reading).

p. If A7C5 doesn't have enough range, A7C4 must be changed to either an 18, 24, or 27 pf capacitor.

q. If A7C4 had to be changed, allow circuit components 10 to 15 minutes to return to room temperature before proceeding. Then repeat steps e through p before proceeding with this procedure.

r. Return frequency dial to 0000 and adjust A7L2 for a frequency counter reading of 3 Mc ± 50 cps.

s. Return frequency dial to 1500. Frequency counter reading should be 4.5 Mc ± 15 kc.

t. Check oscillator frequencies at dial settings of 0001, 0010, 0050, 0100, 0150, 0200, 0300, 0500, 0700, 0900, 1100, 1300, and 1500. Specification: Frequency Counter reading must be equal to 3 Mc $\pm (1\% + 300$ cps) plus dial reading in kilocycles.

u. Corrections for tracking errors can be made at dial settings of 1500 with A7C5. If corrections are made, return frequency dial to 0000 and adjust A7L2 for 3 Mc ± 50 cps. Repeat step t.

v. Disconnect X10 probe from frequency counter and connect to oscilloscope. Tune frequency dial from 0000 to 1500 and note peak-to-peak amplitude of oscilloscope waveform. Peak-to-peak amplitude of the waveform should not vary by more than 10%.

w. Check AGC control voltage variation by tuning frequency dial from 0000 to 1500 and noting dc voltmeter reading. The AGC control voltage as measured by the dc voltmeter should not be less than 3.7V or greater than 8 V.

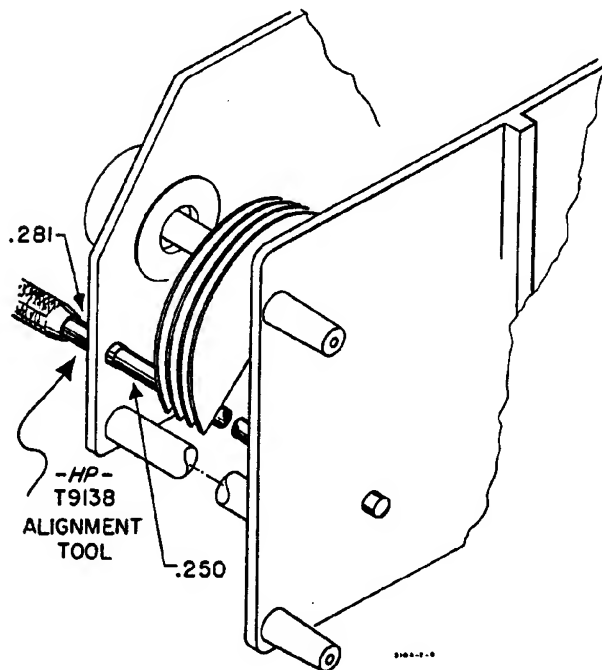


Figure 5-6. Rotor Alignment

5-37. REINSTALLING OF ASSEMBLY.

- Disconnect all clip lead connections.
- Fasten assembly to 310A right side frame.
- Carefully reconnect right side frame and front cover of 310A. Use care not to damage any shafts or instrument parts during re-assembly of instrument.
- Disconnect leads and the short from component side of the A7 circuit board and connect proper instrument leads to board. Yellow lead to YEL, violet lead to VIO, shielded lead from pin 14 of A8 to OUT and shield to ground point, shielded lead from MODE switch to TO AFC and shield to ground point.
- Replace front panel knobs.
- Replace A7 shield cover.

5-38. SWITCH ASSEMBLIES.

5-39. There are five switch assemblies in the 310A:

- A1 Assembly, Input Attenuator (see Figures 5-9, 5-15 and 5-26);
- A6 Assembly, IF Attenuator (see Figures 5-10, 5-17 and 5-26);
- A10 Assembly, Bandwidth Selector (see Figures 5-11, 5-17 and 5-19);
- A16 Assembly, RF Attenuator (see Figures 5-12 and 5-21);
- A18 Assembly, Mode Selector (see Figures 5-13 and 5-21). Since the schematic diagrams in this manual fold completely out of the manual, the switch assembly identification pictures and the schematic diagrams are easily compared to the actual instrument switches.

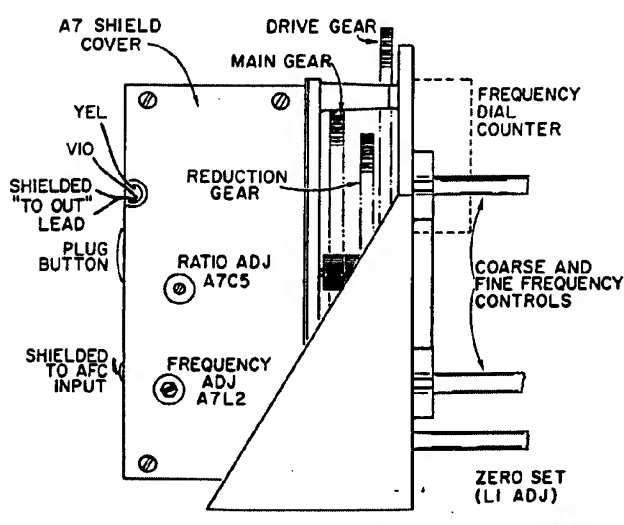


Figure 5-7. Tuning Assembly Adjustment Location

5-40. ADJUSTMENTS.

5-41. POWER SUPPLY ADJUST.

- Measure the voltage at pin 14 of A21. It should be approximately -22 Vdc. This voltage is not critical and may vary by as much as 2 or 3 volts.
- Measure dc voltage between pin 12 of A24 and ground. It should be -15 \pm 0.5 volts. Adjust A24R7 if necessary.
- Measure voltage between pin 1 of A24 and ground. It should be +15 \pm 0.5 volts. Adjust A24R17 if necessary. The 15-volt supplies are independent of each other.

5-42. CALIBRATOR CIRCUIT ADJUST.

- Turn instrument on and place RANGE switch to CAL.
- Use an oscilloscope and 10:1 divider to observe the waveform at the collector of A3Q2. It should be a square wave with about 60/40 symmetry and a minimum amplitude of 6.5 volts peak-to-peak.
- Place an oscilloscope probe to the positive side of C3 (blue lead to filter A4). Adjust R1, Cal. Level Adj., for approximately 60-mV peak-to-peak voltage.

5-43. LOCAL OSCILLATOR ADJUST.

- Refer to Figures 5-3 and 5-7. Remove instrument bottom cover and place instrument on side.
- Connect voltage divider probe from frequency counter to test point B on A8.
- Set ZERO SET to its mechanical mid-point. Set FREQUENCY (KC) to 0000.
- Frequency counter should read 3 Mc \pm 100 cps. If not, adjust A7L2.
- Turn FREQUENCY (KC) to 1500. Frequency counter should read 4.5 Mc \pm 15 kc. If not, adjust A7C5 as follows:
 - If frequency counter reading is high, adjust A7C5 for a reading which is equal to 4.5 Mc minus (0.8 times frequency counter reading minus 4.5 Mc).
 - If frequency counter reading is low, adjust A7C5 for a reading which is equal to 4.5 Mc plus (0.8 times 4.5 Mc minus frequency counter reading).

Note

If A7C5 does not have enough range to properly adjust frequency reading, then the value of A7C4 must be changed (suggested values for A7C4 are 18, 24, or 27 pf).

- If A7C4 is changed, allow circuit to return to room temperature before attempting any further adjustment or measurement.

- Repeat steps d and e.

- Set FREQUENCY (KC) to 0000. Frequency counter must read 3 Mc \pm 50 cps. If not, adjust A7L2.

- Return FREQUENCY (KC) to 1500. Frequency counter must read 4.5 Mc \pm 15 kc. If not, adjust A7C5.

- j. Repeat steps h and i until no adjust is necessary.
- k. Check oscillator frequencies at FREQUENCY (KC) settings of 0001, 0010, 0050, 0100, 0150, 0200, 0300, 0500, 0750, 0900, 1100, 1300, and 1500. Specification: frequency counter readings must be equal to 3 Mc plus dial reading in kilocycles $\pm(1\% + 300 \text{ cps})$.
- m. Corrections for errors must be made at dial setting of 1500 with A7C5.
- n. Observe the waveform at test point B on A8 with an oscilloscope. The waveform should remain essentially sinusoidal over the tuning range of the instrument.
- p. Monitor the voltage at test point B on A8 with a high frequency ac voltmeter. The amplitude should be at least 2.3 volts RMS at 4.5 Mc. The variation in voltage should be less than ± 0.3 volts over the frequency range.

5-44. BFO ADJUST.

- a. With instrument turned on, set MODE to LSB.
- b. Connect an oscilloscope voltage divider probe to test point H on A19. Set BFO Level Adj., A19R5 fully counterclockwise.
- c. Adjust A19C3 for minimum oscillator turn-on time as the MODE is switched from AM to USB. Switch to LSB and BFO and check that oscillation occurs.
- d. Disconnect probe from oscilloscope and connect to frequency counter. Monitor the frequency at test point H. Switch MODE to BFO. Note the frequency as f_0 .
- e. Switch to USB. Adjust A19C7 to $(f_0 + 1450 \text{ cps}) \pm 50 \text{ cps}$.
- f. Switch to LSB. Adjust A19C6 to $(f_0 - 1450 \text{ cps}) \pm 50 \text{ cps}$.
- g. Repeat steps e and f for the proper frequencies.
- h. Set MODE to BFO. Set AMPLITUDE control fully clockwise. Monitor the OUTPUT voltage with an ac voltmeter. Adjust A19R5 for a reading of 1.1 ± 0.02 volts.

5-45. INITIAL CRYSTAL OSCILLATOR ADJUST.

- a. Connect oscilloscope probe to A11C4.
- b. Adjust A11C1 and A11C4 for maximum amplitude.
- c. Remove oscilloscope and connect ac voltmeter to A11C4. Adjust A11R4 for 6.5V RMS.
- d. Remove ac voltmeter.

5-46. FIRST MIXER PAIR ADJUST.

- a. Connect oscilloscope vertical input to test point D on A13. Connect oscilloscope horizontal input to test point D on A14. Set oscilloscope sensitivity to 100 mV/cm on each channel.

CAUTION

DO NOT GROUND TEST POINT D. Grounding testpoint D will destroy transistor A13Q6 or A14Q6.

- b. Set 310A RANGE to CAL and BANDWIDTH to 1000 cps and FREQUENCY (KC) for maximum meter indication (approximately 100 Kc).

- c. Adjust R1 (CAL level adjust) for a reasonable signal amplitude on oscilloscope (refer to Figure 5-3).

- d. Shunt A9C11 and A9C16 each with an 18 ohm resistor. Repeat step c.

- e. Adjust A9C13 and A9C18 for symmetrical Lissajous patterns around both horizontal and vertical axes.

- f. Connect an RF voltmeter to A11C4. Adjust A11C1 and A11C4 for maximum indication on the voltmeter (this checks the adjustment of these two capacitors).

- g. Adjust A11R4 to obtain 6.5 volts RMS on the RF voltmeter.

- h. Tune A9C11 and A9C16 for maximum circle amplitude on the oscilloscope.

5-47. ACTIVE FILTER OSCILLATOR.

- a. Connect frequency counter to A11C4.
- b. Adjust A11C3 to $(f_0 + 35 \text{ cps}) \pm 5 \text{ cps}$ (f_0 from paragraph 5-43).

5-48. SECOND MIXER PAIR.

- a. Set RANGE to CAL, MODE to BFO, OUTPUT fully clockwise.
- b. Connect oscilloscope to OUTPUT.
- c. Adjust A19R5 for maximum output amplitude.
- d. Tune A19C7 until oscilloscope indicates maximum output.
- e. Switch MODE to NORMAL. Adjust A17R10 for an output amplitude of approximately 1.5V peak-to-peak.
- f. Decrease the oscilloscope sweep speed to observe the "summing" error.

Note

The "summing" error appears as low frequency signal riding on the 100-kc OUTPUT.

- g. Adjust A15C2 and A15C7 and A15R6 for minimum "summing" error on OUTPUT signal.

5-49. ACTIVE FILTER MIXER CARRIER BALANCE.

- a. Short test points C on A13 and A14 to ground.
- b. Set MODE to NORMAL, and RANGE to -60.
- c. Alternately adjust A15C3 and A15C8 for a minimum meter indication (less than 2% of full scale). Remove shorts.

5-50. OUTPUT.

- a. Set RANGE to CAL, MODE to NORMAL, OUTPUT amplitude CW.
- b. Connect oscilloscope to OUTPUT.
- c. Adjust OUTPUT amplitude for approximately 1.5V peak-to-peak.
- d. Adjust A15R6 for minimum "summing" error as indicated on oscilloscope.
- e. Repeat SECOND MIXER PAIR adjustment if necessary for minimum "summing" error.

5-51. BANDWIDTH FLATNESS.

- a. Recheck carrier balance as in Paragraph 5-48.
- b. Set RANGE to CAL, MODE to NORMAL, tune the FREQUENCY dial through the 100-kc calibrate signal and observe the response characteristics of the filters as indicated on the front panel meter. Check all three bandwidth positions. Switch to RELATIVE and set REF ADJUST if needed to obtain on-scale meter indications.
- c. Adjust symmetry of the bandpass flat top with A9C7.
- d. Tune A8C5 for maximum meter reading.

5-52. INPUT MIXER CARRIER BALANCE.

- a. Set MODE to NORMAL, BANDWIDTH to 200 cps, RANGE to give an on-scale indication, FREQUENCY to 0000, ZERO SET for maximum meter indication.
- b. Balance the mixer for a minimum reading by alternately adjusting A8C4 and A8R9. Temporarily install the metal shield to insure a correct null when adjusting A8C4.

5-53. 3-DB BANDWIDTH CHECKS.

- a. Set RANGE to 0dB, MODE to NORMAL, MAX INPUT VOLTAGE to 10 or 3, BANDWIDTH to 200 cps.
- b. Connect oscillator to INPUT. Set oscillator frequency to 10 kc. Monitor on an electronic counter.
- c. Turn FREQUENCY dial for maximum indication on 310A meter.
- d. Tune oscillator frequency to 10, 108 cps, and then to 9,892. Reading should reduce 3 dB.
- e. Set BANDWIDTH to 1000 cps. Tune oscillator frequency ± 550 cps about 10 kc; reading should reduce 3 dB.
- f. Set BANDWIDTH to 3000 cps. Tune oscillator frequency ± 1550 cps about 10 kc; reading should reduce 3 dB.

5-54. OUTPUT AMPLITUDE ADJUST.

- a. Set MODE to BFO and OUTPUT AMPLITUDE fully clockwise.
- b. Connect an RF voltmeter, such as the \odot Model 400H, to the OUTPUT.
- c. Adjust A19C17 for maximum output.
- d. Set FREQUENCY (KC) to 100 kc and adjust A19R5 for a reading of 1.08 ± 0.02 V RMS.
- e. Switch MODE to NORMAL, RANGE to CAL, BANDWIDTH to 3000 cps, ABSOLUTE-RELATIVE to ABSOLUTE, and tune FREQUENCY (KC) for maximum 310A meter indication. Adjust CAL for meter indication of 1.0.
- f. Adjust A17R10 for a reading of 0.54 ± 0.02 on the RF voltmeter.
- g. Replace voltmeter with oscilloscope.
- h. Tune for maximum 310A meter indication. Switch MODE to LSB.
- i. The OUTPUT signal should be about 1.5 volts peak-to-peak at a frequency of about 1.5 kc.
- j. Switch MODE to USB. The output should be the same as measured in step i.

5-55. AFC-AGC LEVEL ADJUST.

- a. Set RANGE to 0dB, MODE to NORMAL, MAX INPUT VOLTAGE to 1V, BANDWIDTH to 3000 cps.
- b. Connect an oscillator tuned to 10 kc to the INPUT. Tune the FREQUENCY dial for maximum indication on the meter. Adjust meter reading to full scale with the level control on the oscillator.
- c. Overload the 310A by changing the MAX INPUT VOLTAGE to .3V.
- d. Connect an oscilloscope to junction of A22R22 and A22R24.
- e. With oscilloscope set to 1 ms/cm (sweep time) and 0.5 V/cm (sensitivity) and the 10X attenuator oscilloscope probe connected to junction of A22R22 and A22R24, adjust A22R16 so that the peaks of the half-wave rectifier signal are just clipped.

5-56. AFC TRIGGER LEVEL ADJUST.

- a. Set RANGE to 0dB, MODE to NORMAL, MAX INPUT VOLTAGE to 1V, BANDWIDTH to 3000 cps.
- b. Connect an oscillator tuned to 10 kc to the INPUT. Tune the FREQUENCY dial for maximum indication on the meter. Adjust output amplitude control of the oscillator for a full scale 310A meter reading.
- c. Connect an oscilloscope to test point K on A22 and a DC VTVM (+3V scale) to the junction of A22R19, R20, R21, and R22.
- d. Note oscilloscope presentation on either side of the center frequency point it is an unsymmetrical square wave. Tune the FREQUENCY (KC) control to one side of center frequency. Adjust A22R18 for a flop of the square wave and record voltmeter reading. Tune the FREQUENCY (KC) control to the other side of center frequency. Adjust A22R18 for a flip of square wave. Record voltmeter reading.
- e. Add the two voltage readings of step d together and divide by two to find the average value. Adjust A22R18 to this average value. For example: if the first reading of step d was 3.0 and the second reading was 1.0, set A22R18 for a voltmeter reading of 2.0.

5-57. OUTPUT LEVEL ADJUST.

- a. Set RANGE to 0dB, MODE to NORMAL, MAX INPUT VOLTAGE to 1V, BANDWIDTH to 3000 cps.
- b. Connect an oscillator tuned to 10 kc, to the INPUT. Tune the FREQUENCY dial for maximum indication on the meter.
- c. Connect DC VTVM to test point L on A23 and an electronic counter to the collector of A22Q1. For Specification H02-310A instruments, capacitor A22C16 has an additional capacitor of equal value connected in parallel with it. Disconnect one lead of either capacitor before performing step d (if this is not done then the frequency measured in step d must be 27.5 cps instead of 55 cps).
- d. Decrease the input frequency from the oscillator until the meter reading starts to drop off. Staying on the same side of the bandpass, increase the frequency until the counter reads 55 cps.
- e. Adjust A23R20 so that VTVM reads -0.5V.

5-58. AFC OUTPUT CUTOFF ADJUST.

- a. Set RANGE to 0dB, MODE to NORMAL, MAX INPUT VOLTAGE to 1V, BANDWIDTH to 3000 cps.
- b. Connect an oscillator tuned to 10 kc to the INPUT. Tune the FREQUENCY dial for maximum indication on the meter.
- c. Set A23R46 full CW.
- d. Connect a DC VTVM to C20 (white-green wire).
- e. Change the MODE switch to AFC.
- f. Decrease the input frequency from the oscillator until the VTVM reads -0.5V.
- g. Slowly adjust A23R46 CCW until the VTVM reading suddenly drops.

5-59. AFC HOLD-OFF LEVEL ADJUST.

- a. Set RANGE to 0 dB, MODE to NORMAL, BANDWIDTH to 1000 cps, MAX INPUT VOLTAGE to 1V.
- b. Connect an oscillator tuned to 10 kc through an attenuator to INPUT.
- c. Tune FREQUENCY dial for maximum meter indication.
- d. Attenuate input by 60 dB. Set RANGE to -60 dB.
- e. Tune FREQUENCY dial just above input frequency. Adjust A23R27 so that signal is pulled in at 25% of full scale.

5-60. INITIAL INPUT ATTENUATOR ADJUST.

- a. Set RANGE to -30dB, BANDWIDTH to 1000 cps, MODE to NORMAL, MAX INPUT VOLTAGE to 0.01, ABSOLUTE-RELATIVE to ABSOLUTE.
- b. Connect frequency response set for 0.3 millivolts at 1 Mc. Tune FREQUENCY (KC) for maximum 310A meter indication and switch MODE to AFC.
- c. Adjust input signal amplitude for 310A meter indication of 0.96.
- d. Roughly preset the adjustment of the input attenuator compensating capacitors as indicated below to give the same meter reading on each range as INPUT signal is increased in 10-dB steps.

Max Input Voltage	Freq Resp Set	Capacitor
.01	- - -	No adjustment
.03	.001	A2C1
.1	.003	A2C2
.3	.01	A2C3
1	.03	A2C4
3	.1	A2C5
10	.3	A1C6
30	1	A1C6
100	3	A1C6

- e. Disconnect frequency response set and replace with oscillator connected to INPUT through precision attenuator, such as @ Model 355B/D, which has been calibrated to an accuracy of $\pm 0.5\%$ from 0 to -80 dB at 10 kc.

- f. Set RANGE to -30 dB, BANDWIDTH to 1000 cps, MODE TO NORMAL, and tune FREQUENCY (KC) for

maximum meter indication with the MAX INPUT VOLTAGE switch at .01 and the precision attenuator at -80 dB.

- g. Switch MODE to AFC and adjust input signal amplitude for 310A meter indication of 0.96.

- h. Switch MAX INPUT VOLTAGE from .01 to 100 and as indicated below record + and - variation from 0.96 reference meter reading on each range as attenuation is decreased in 10-dB steps.

Max Input Voltage	Attenuation (dB)	Max Meter Variation
		0.99 0.96 0.93
.01	80	0
.03	70	
.1	60	
.3	50	
1	40	
3	30	
10	20	
30	10	
100	0	

- j. If the maximum meter variation exceeds the limits specified (0.99 to 0.93), the most common cause is ground currents flowing in the MAX INPUT VOLTAGE or RANGE switch assemblies. Ground leads on the switch assemblies should not contact on the switch. Check resistor values; a bad resistor will cause attenuation error. Repeat step h and be sure attenuation is correct before proceeding.

- j. Set RANGE to 0 dB, MAX INPUT VOLTAGE to 0.3. Set Precision Attenuator to -80 dB and adjust input signal amplitude for 310A meter indication of 0.96.

- k. Switch RANGE from 0 to -60 and as indicated below record + and - variation from 0.96 reference meter reading on each range as attenuation is decreased in 10-dB steps.

Range	Attenuation (dB)	Max Meter Variation
		0.99 0.96 0.93
0	80	0
-10	70	
-20	60	
-30	50	
-40	40	
-50	30	
-60	20	

- m. If maximum meter variation exceeds the limits specified (0.99 to 0.93), the cause is ground currents flowing in the MAX INPUT VOLTAGE or RANGE switch assemblies or bad resistors. Ground currents are usually caused by contact ON THE SWITCH of ground leads. If excessive error is noted and corrected, repeat entire procedure.

5-61. FINAL INPUT ATTENUATOR ADJUST.

- a. Connect oscillator to input of frequency response set.
- b. Connect output of frequency response set to INPUT of 310A.
- c. Set oscillator to 10 kc and set 310 as follows:

RANGE to -30 dB, MAX INPUT VOLTAGE to .01 ABSOLUTE-RELATIVE to RELATIVE, MODE to NORMAL, and FREQUENCY (KC) tuned for maximum meter indication.

d. Switch MODE to AFC and adjust amplitude of input signal for 0.96 meter indication. Establish a reference on frequency response set meter.

e. Switch MAX INPUT VOLTAGE switch from .01 to 100 and switch frequency response set attenuator over same range (the reference set on the frequency response set meter must be maintained throughout check). Record 310A meter readings on each step of the MAX INPUT VOLTAGE switch; record 310A meter readings.

f. Disconnect oscillator from frequency response set and tune for 0.3 millivolts at 1 Mc.

g. Set 310A RANGE to -30 dB, BANDWIDTH to 1000 cps, MODE to NORMAL, MAX INPUT VOLTAGE to .01.

h. Tune FREQUENCY (KC) for maximum meter indication and switch MODE to AFC.

i. Adjust input signal amplitude for 310A meter indication of 0.96.

j. Set and maintain the same reference on the frequency response set meter as in step d, above.

k. Adjust the capacitors to give the same meter reading on each range except as indicated below.

m. Using the oscillator at 100 kc, repeat steps g through j at frequencies of 100 kc, 400 kc, 600 kc, and 1.5 Mc. Maximum deviation on each range should not exceed ± 0.6 . If error is excessive at any setting, repeat step k and compensate for attenuator errors by changing capacitor settings.

5-62. FINAL CALIBRATOR ADJUSTMENT.

a. Set RANGE to 0 dB, MAX INPUT VOLTAGE to .01, MODE to NORMAL, BANDWIDTH to 1000 ν , FREQUENCY to 0100.

b. Connect oscillator, tuned to 100 kc, to 310A INPUT. Tune oscillator to obtain indication of 310A. Switch MODE to AFC.

c. Connect AC VTVM to INPUT terminals. Adjust oscillator to obtain 9.6 mV.

d. Adjust 310A CAL to give 9.6 mV.

e. Switch RANGE to CAL and MODE to NORMAL.

f. Adjust A3C4 for maximum 310A reading.

g. Adjust R1 for full scale meter reading (1.0).

Max Input Voltage	Frequency Response Set Settings	Adjust to Step E Reading Plus	Capacitor Adjust
.01	- - -	- - -	No Adjustment
.03	.0001	+.01	A2C1
.1	.0003	+.01	A2C2
.3	.01	+.005	A2C3
1	.03	- - -	A2C4
3	.1	- - -	A2C5
10,	.3	+.02, -.00	A1C6
30	1	+.02, -.00	A1C6
100	3	+.02, -.00	A1C6

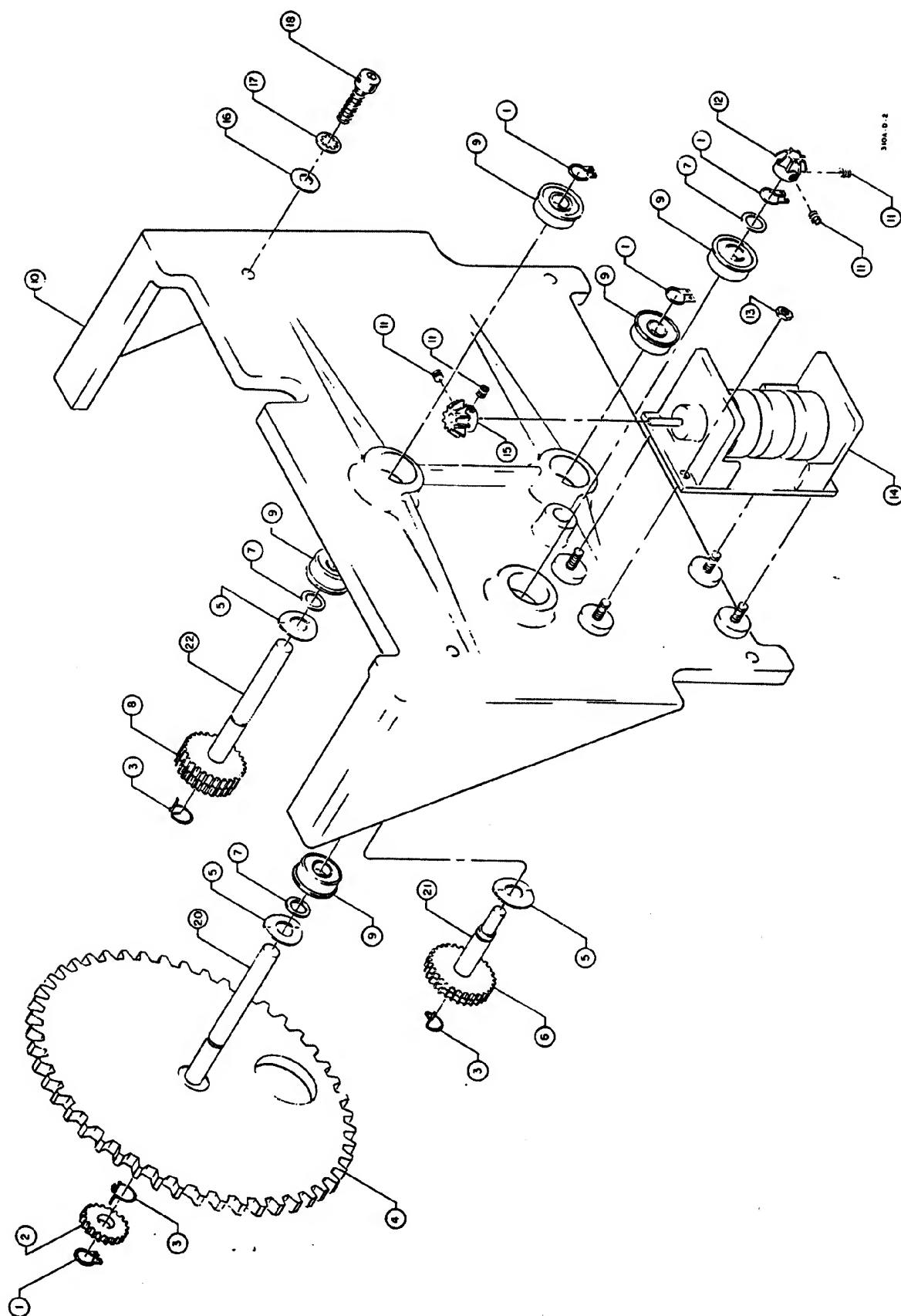


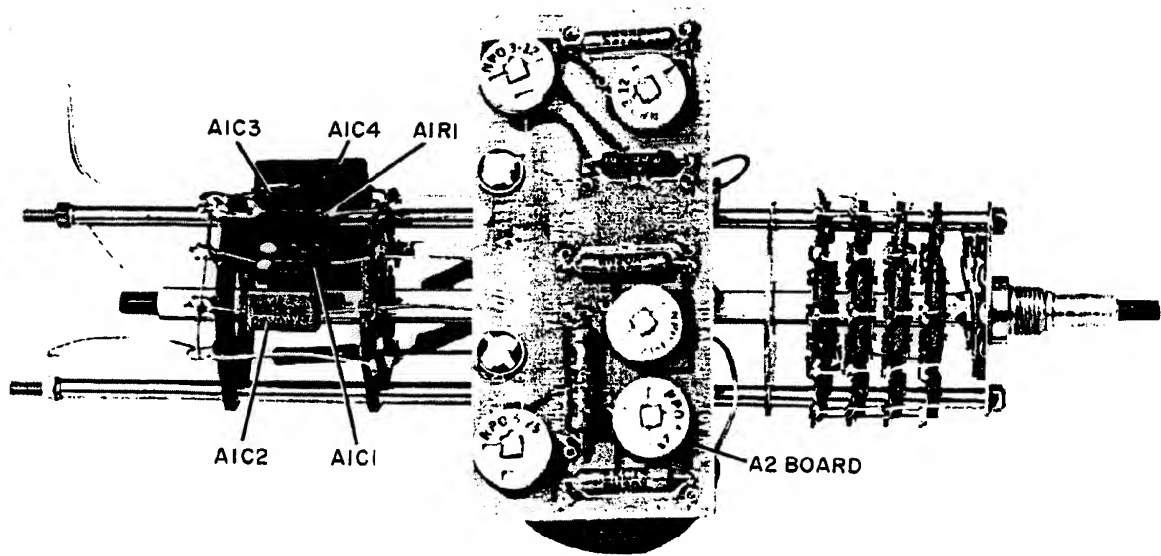
Figure 5-8. Frequency Counter Drive Assembly

Table 5-6. Tuning Assembly Parts Identification

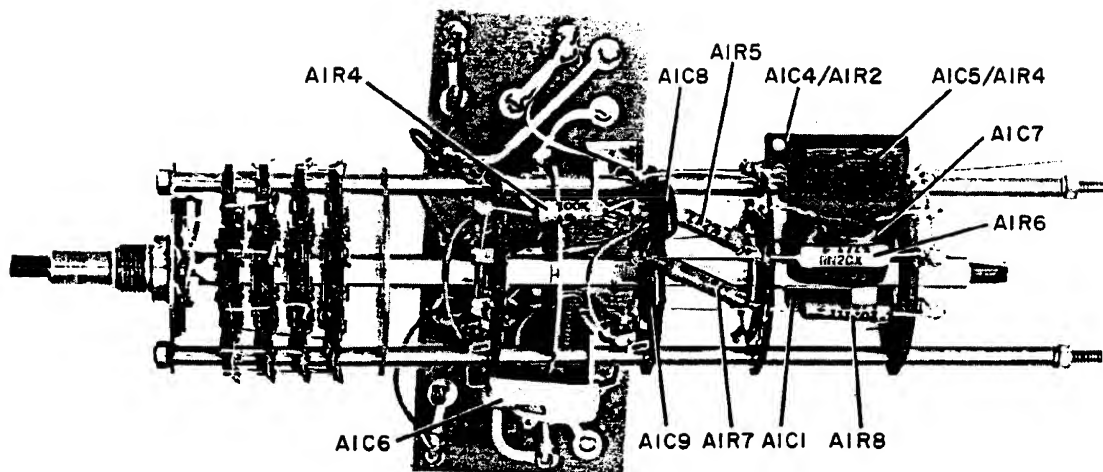
Figure No.	Item No.	Description	Stock No.
5-4	1	Shield, capacitor	302-55E
	2	Machine screw, 10-32 x 1-1/4 in	---
	3	Washer, #10 int lock	---
	4	Washer, stator clamp	302A-88B
	5	Washer, insulating	302A-88A
	6	Lock nut	2950-0032
	7	Set screw	3010-0025
	8	Ball bearing 1/8-in.-diameter	1410-0005
	9	Machine screw, 10-32 x 3/4 in.	---
	10	Washer, #10 flat	---
	11	Rear casting	302A-82A
	12	Coil - A7L2	
	13	A7 Local Oscillator Board	
	14	Washer, #6 int lock	---
	15	Machine screw, 6-32 x 3/8 in. (with lock washer)	---
	16	Retaining ring	0510-0005
	17	Bearing 1/4-in. (with flange)	1410-0015
	18	Machine screw, G-32 x 1/2 in (with lock washer)	---
	19	Plate, rotor adjust	302A-82F
	20	Slider, rotor adjust	302A-82G
	21	Bearing, 1/4-in. diameter	1410-0004
	22	Spacer, 5/8 in length	0380-0010
	23	Washer, #6 ext lock	---
	24	Machine screw, 6-32 x 1 in.	---
	25	Machine screw, 4-40 x 3/16 in.	---
	26	Washer, #4 int lock	---
	27	Clip spring	1400-0108
	28	Spacer, 0.484-in. length	0380-0035
	29	Insulator, stator	302A-88E
	30	Zero set coil - L1	
	31	Bracket, zero set	302A-12H
	32	Washer, (1/4-in. diameter) int lock	---
	33	Machine screw, 1/4-28 x 3/8 in.	---
	34	E ring, 1/4 in.-diameter	0510-0083
	35	Hex nut, 1/2-32	0590-0038
	36	Stator assembly	302A-7A
	37	Rotor assembly, variable	302A-7E
	38	Pin drive	1480-0058
	39	Washer, spring	302A-88D
	40	Front casting	302A-L-312
	41	Gear, off set tooth	G-24C-8
	42	Bushing	302A-17D
	43	Washer, spring	M-29A
	44	Shaft, stop gear	310A-32F
	45	Gear, stop	628A-36A-6
	46	Set screw, 8-32 x 3/16 in.	---
	47	Spring, gear loading	1460-0054
	48	Gear B, loading	310A-24H
	49	Shaft, reduction gear	310A-37A
	50	Pinion, reduction gear	310A-24A
	51	Gear, reduction	310A-24G
	52	Machine screw, 4-40 x 3/8 in, fillister head	---
	53	Stop, main gear	302A-113A
	54	Gear, main	310A-24J

Table 5-7. Counter Drive Parts Identification

Figure No.	Item No.	Description	Ⓒ Stock No.
5-8	1	Retaining ring	0510-0005
	2	Gear C, loading	310A-24D
	3	Spring, torsion	1460-0105
	4	Gear, drive	310A-24C
	5	Washer, spring	M-29A
	66	Gear D, loading	310A-24F
	7	Washer, #10 flat	3050-0002
	8	Pinion D	310A-24E
	9	Bearing (with flange)	1410-0015
	10	Front plate	310A-20A
	11	Set screw, G-32 x 1/8 in.	3030-0022
	12	Gear, miter	1430-0036
	13	Hex nut, 6-32	2420-0003
	14	Counter	1140-0011
	15	Gear, miter	1430-0037
	16	Washer, #10 flat	3050-0002
	17	Washer, #10 int lock	2190-0011
	18	Screw, cap 10-32 x 3/4 in.	3030-0035

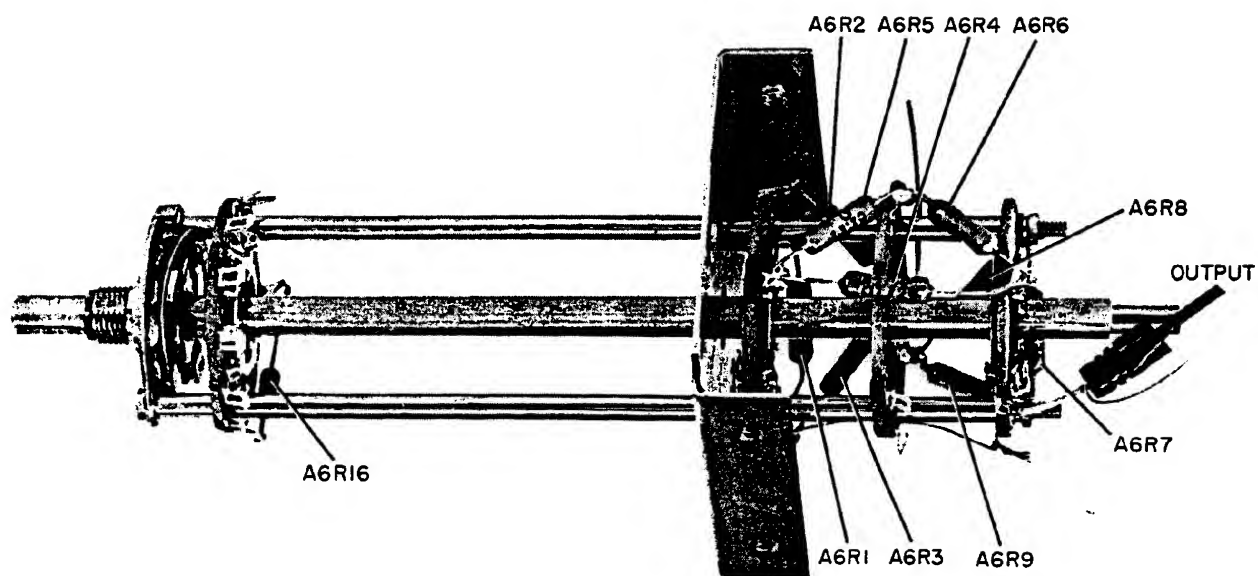


310A-A-18



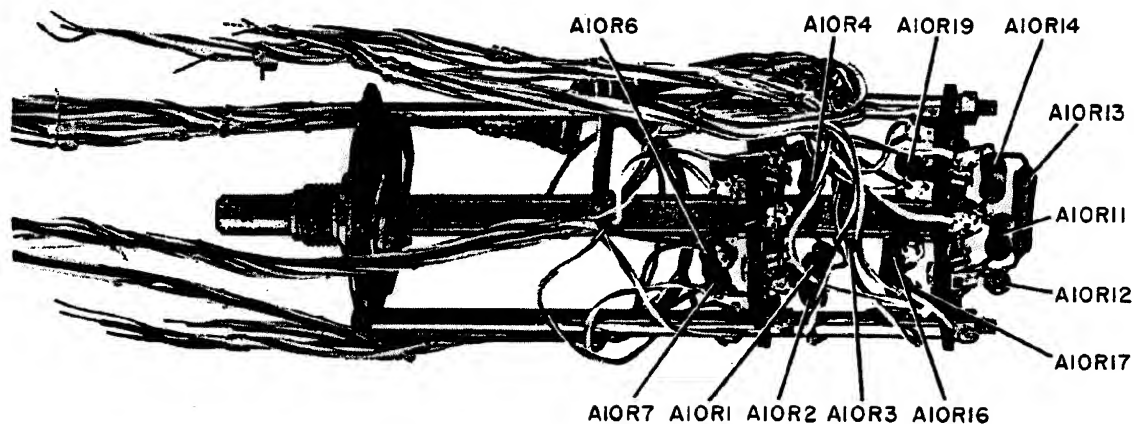
310A-A-20

Figure 5-9. Input Attenuator (Max Input Voltage SW)

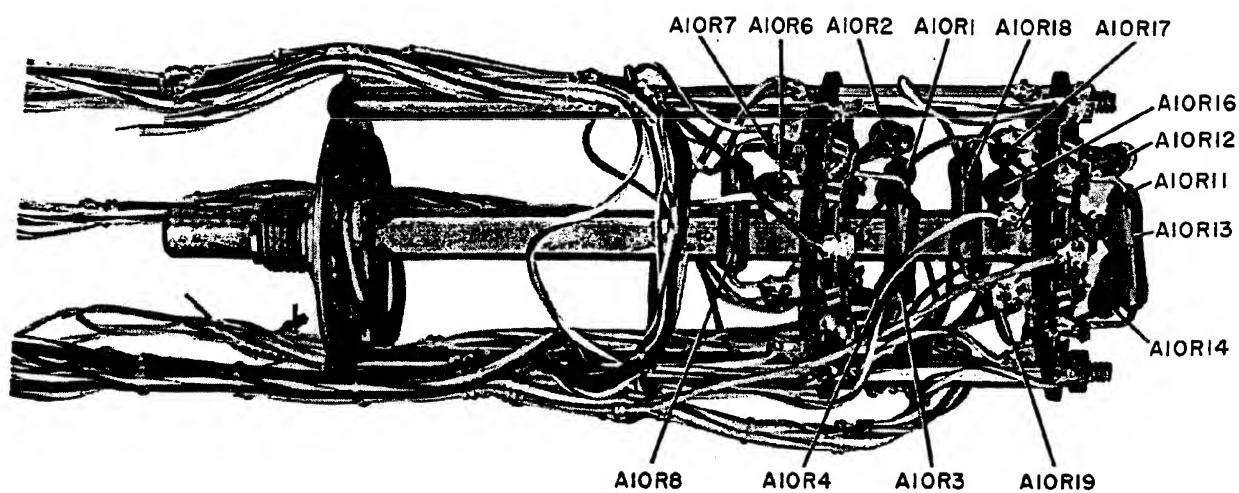


310A-A-15

Figure 5-10. IF Attenuator (Half of Range SW)

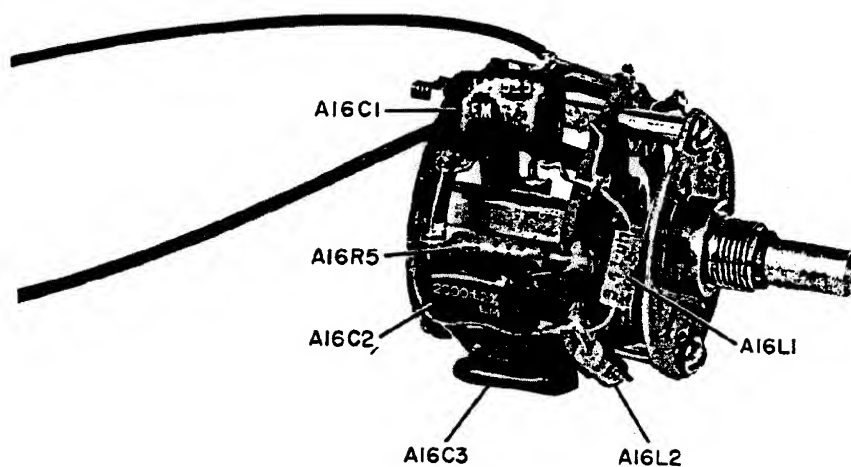


310A - A - 17

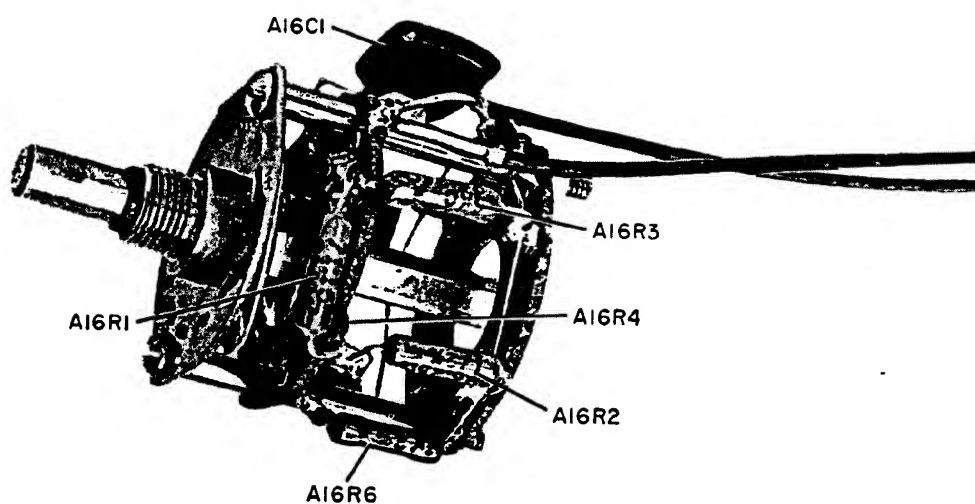


310A - A - 21

Figure 5-11. Bandwidth Selector (Bandwidth SW)

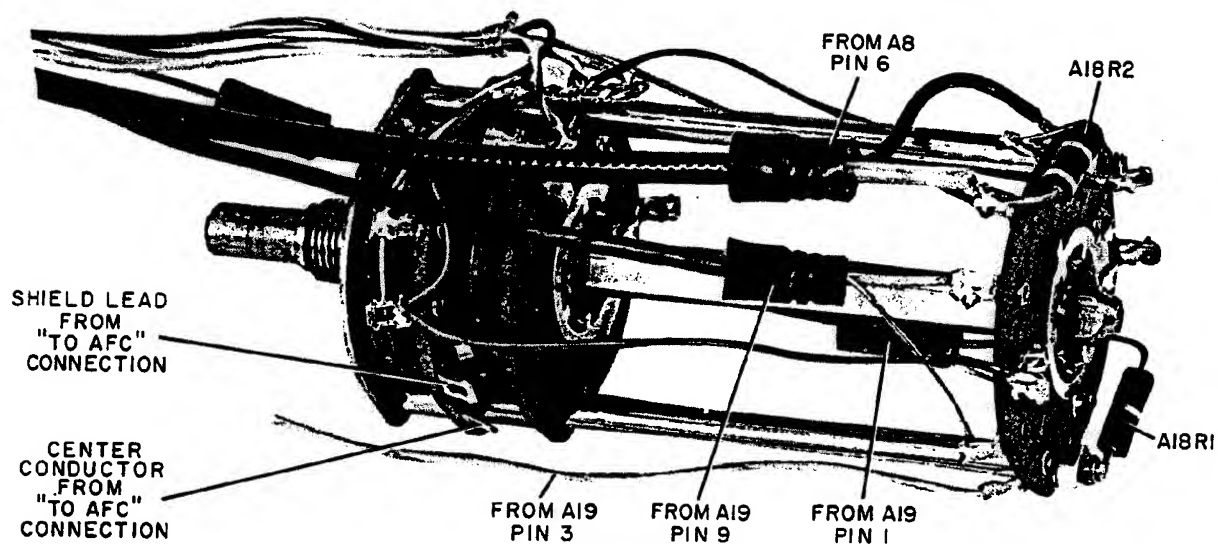


310A - A - 18



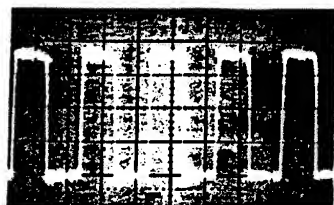
310A - A - 19

Figure 5-12. RF Attenuator (Half of Range SW)

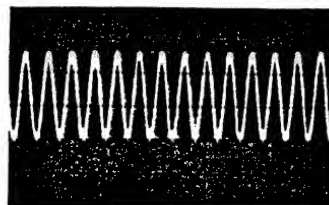


310A-A-14

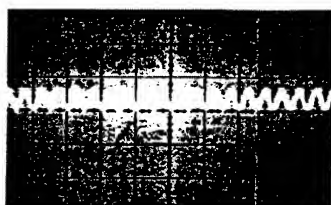
Figure 5-13. Mode Selector (Mode SW)



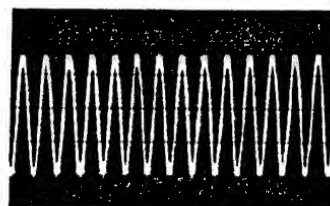
COLLECTOR OF A3Q2
7 V P-P
(RANGE: CAL
SWEEP 5 USEC/CM)



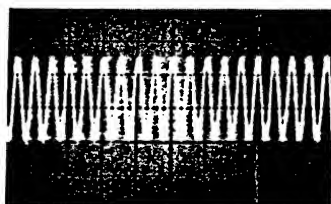
BASE OF A8Q1
130 MV P-P
(SWEEP 0.5 USEC/CM)



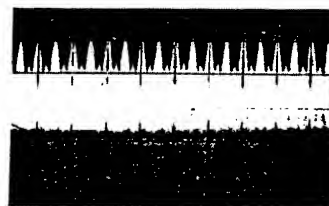
BASE OF A3Q3
30 MV P-P
(SWEEP 0.2 MSEC/CM)



JUNCTION OF A8T2 & A8
7 V P-P
(SWEEP 0.5 USEC/CM)



COLLECTOR OF A3Q5
130 MV P-P
(SWEEP 0.2 MSEC/CM)



JUNCTION OF A8T3 & A8
27 MV P-P
(SWEEP 0.2 MSEC/CM)

310A-C-2

MEASUREMENT CONDITIONS:

- Model 310A set to NORMAL, 10 kc, 3000 cps, AMPLITUDE cw, 1V, and ODB (CAL for A3Q2 measurement)
- Model 175A with X10 probe set to 0.1 msec/cm, and appropriate vertical sensitivity.
- Model 200S Oscillator set to 10 kc and for a 1-volt Model 310A meter reference.

Figure 5-14. Input Amplifier, Local Oscillator and Mixer Waveforms

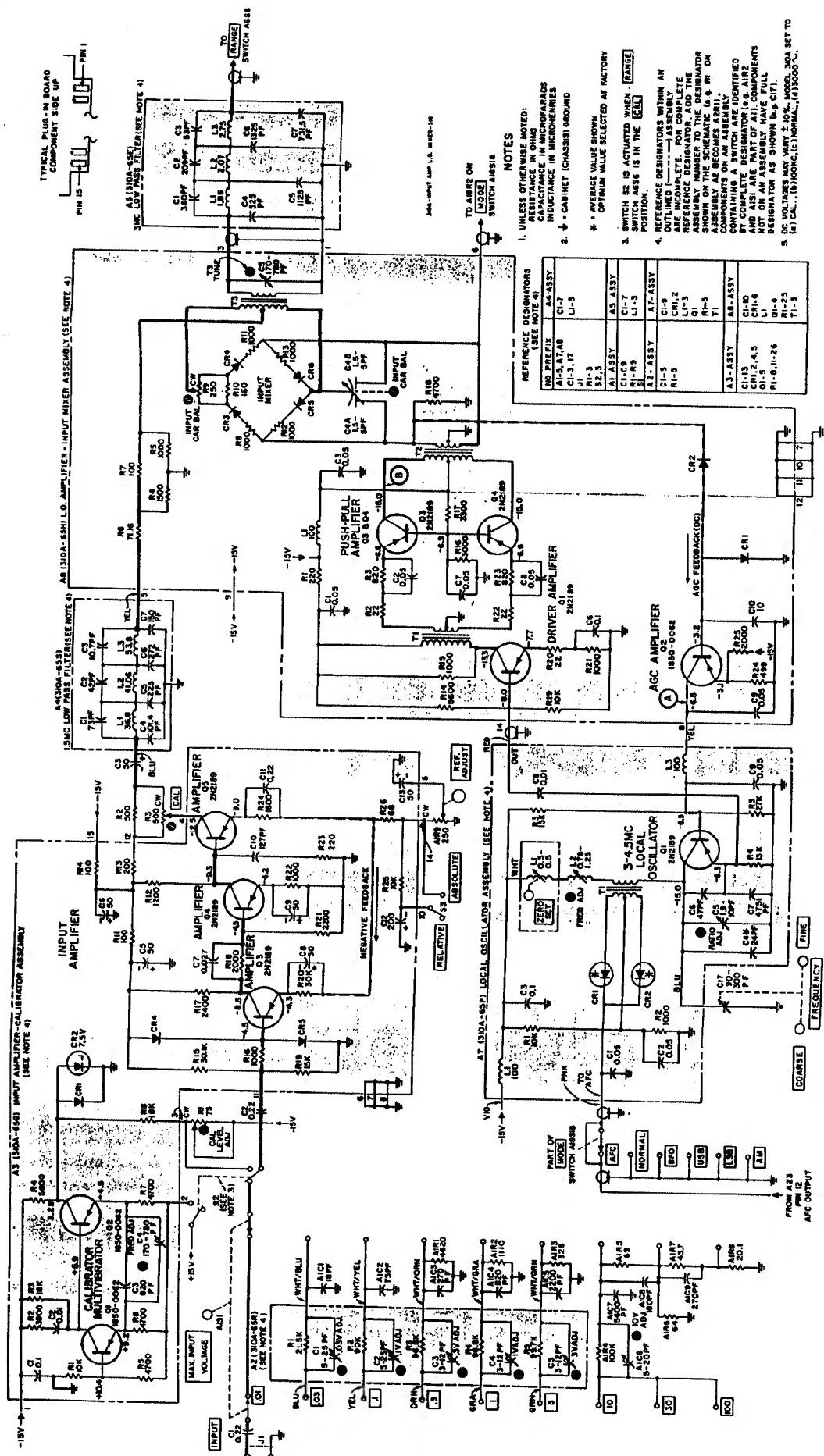
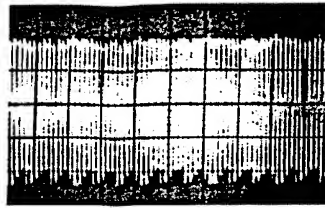
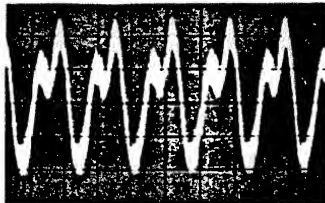


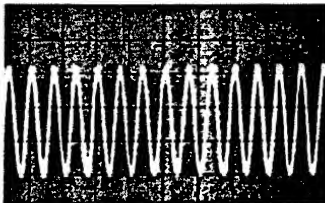
Figure 5-15. Input Amplifier, Mixer, and Local Oscillator



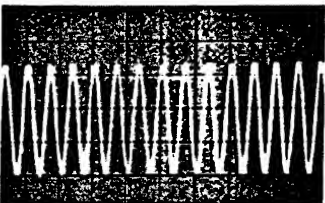
EMITTER OF A9Q1
84 MV P-P
(0.5 USEC/CM)



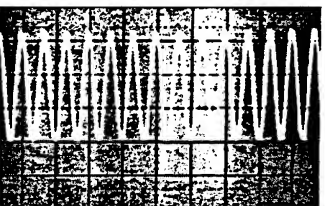
JUNCTION OF A9R20 & A9R2
45 MV P-P
(2 USEC/CM)



COLLECTOR OF A11Q1
6.2 V P-P
(0.5 USEC/CM)



JUNCTION OF A11C6 & A11L2
17 V P-P
(0.5 USEC/CM)



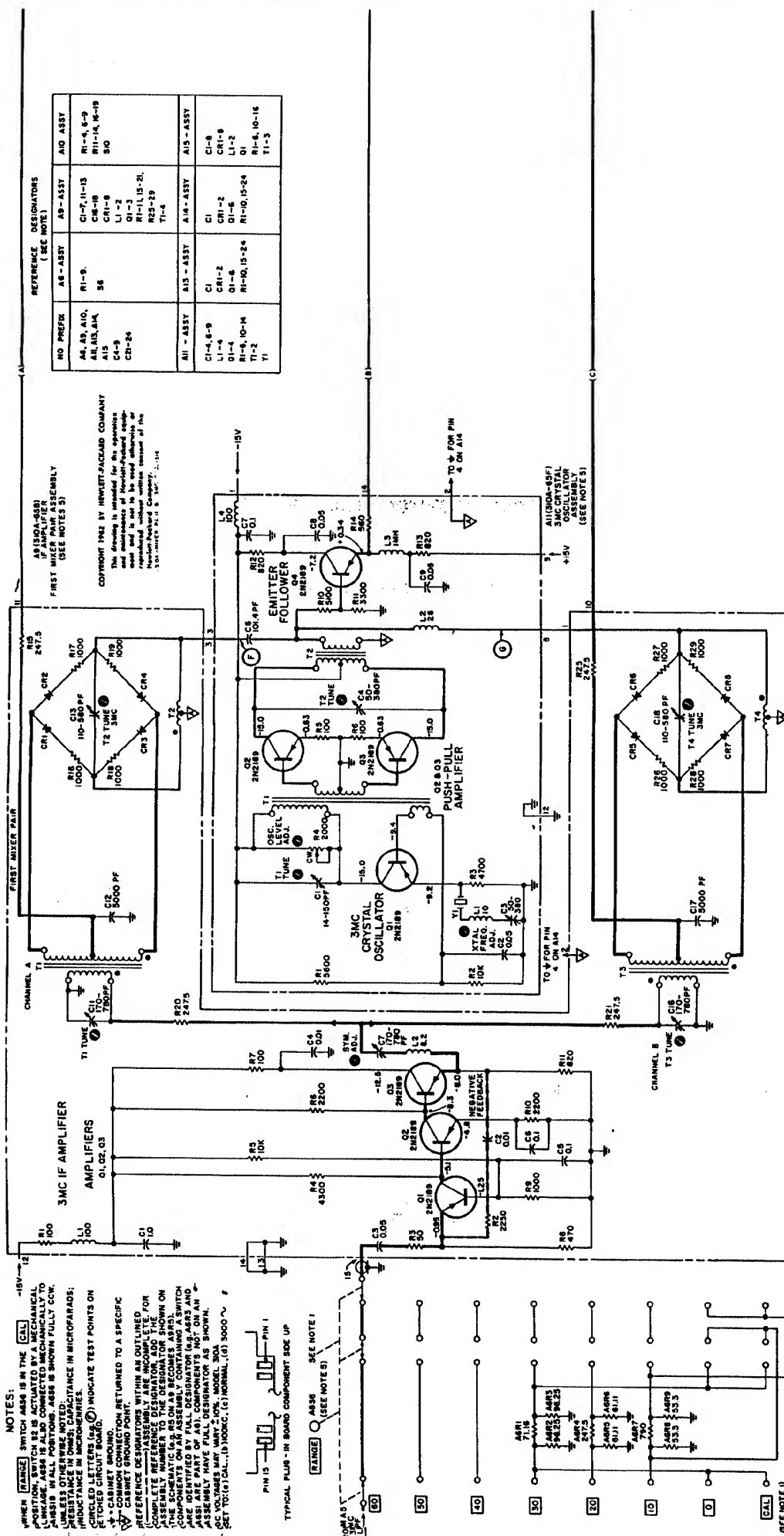
EMITTER OF A11Q4
6.2 V P-P
(0.5 USEC/CM)

310A-G-4

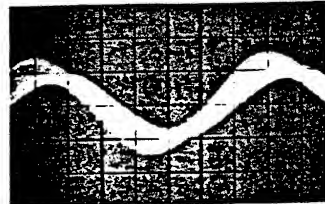
MEASUREMENT CONDITIONS:

- a. Model 310A set to NORMAL, 10 kc, 3000 cps, AMPLITUDE cw, 1V, and ODB.
- b. Model 175A with X10 probe set to 0.1 msec/cm, and appropriate vertical sensitivity.
- c. Model 200S Oscillator set to 10 kc, and for a 1-volt Model 310A meter reference.

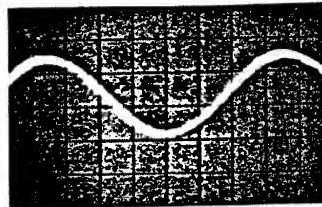
Figure 5-16. First Mixer Pair and 3-Mc Crystal Oscillator Waveforms



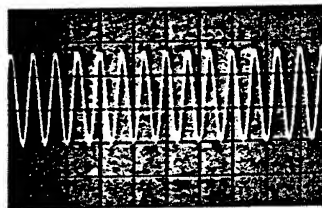
**Figure 5-17. First Mixer Pair,
3 MC Crystal Oscillator**
5-27/5-28



TEST POINTS C
60 MV P-P
(5 MSEC/CM)



TEST POINTS D
1.3 V P-P
(5 MSEC/CM)



COLLECTOR OF A15Q1
13 V P-P
(0.5 USEC/CM)

310A-C-1

MEASUREMENT CONDITIONS:

- a. Model 310A set to NORMAL, 10 kc, 3000 cps, AMPLITUDE cw, 1V, and ODB.
- b. Model 175A with X10 probe set to 0.1 msec/cm, and appropriate vertical sensitivity.
- c. Model 200S Oscillator set to 10 kc, and for a 1-volt Model 310A meter reference.

Figure 5-18. Active LPF and Second Mixer Pair Waveforms

Section V
Figure 5-19

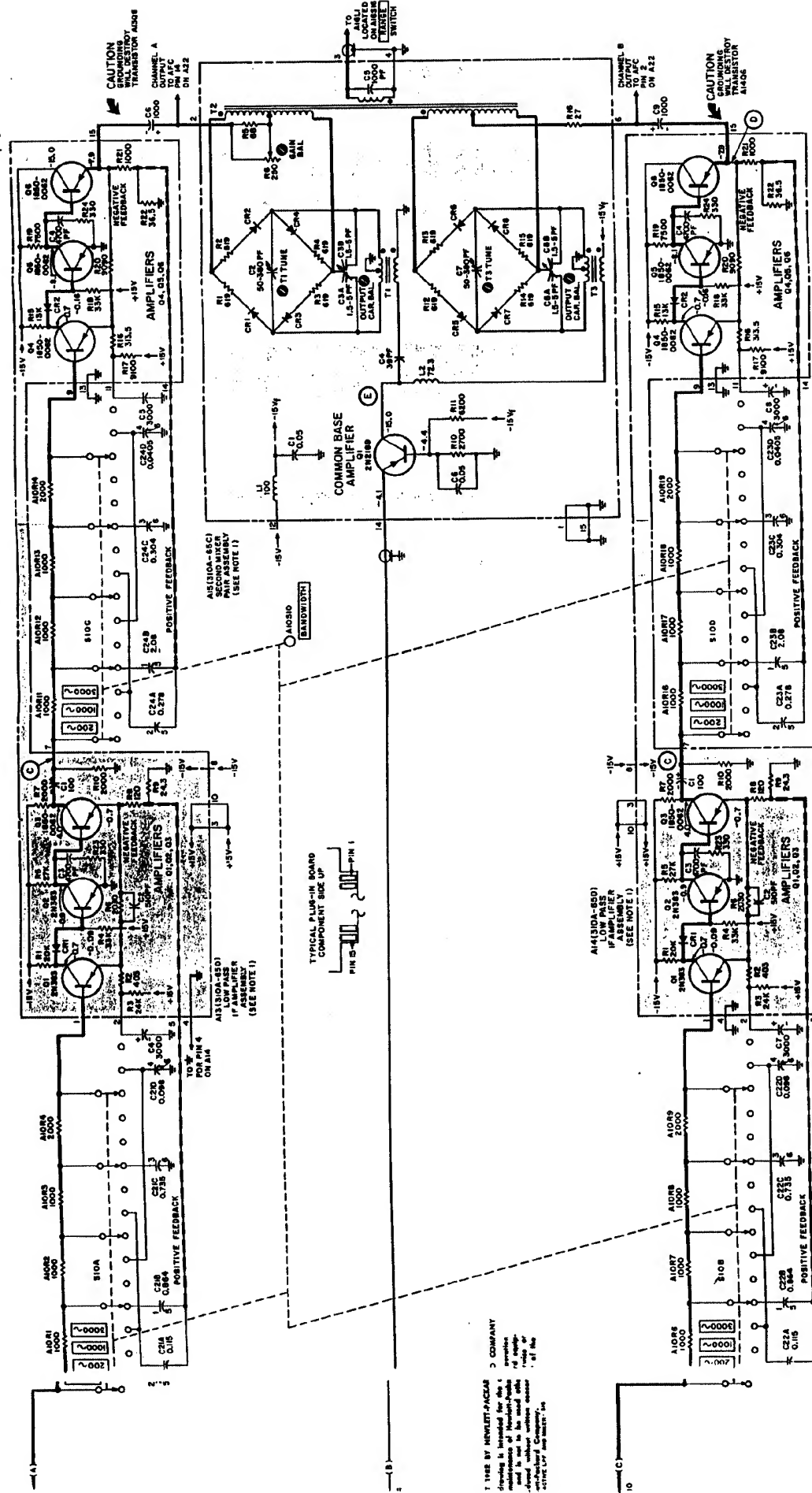
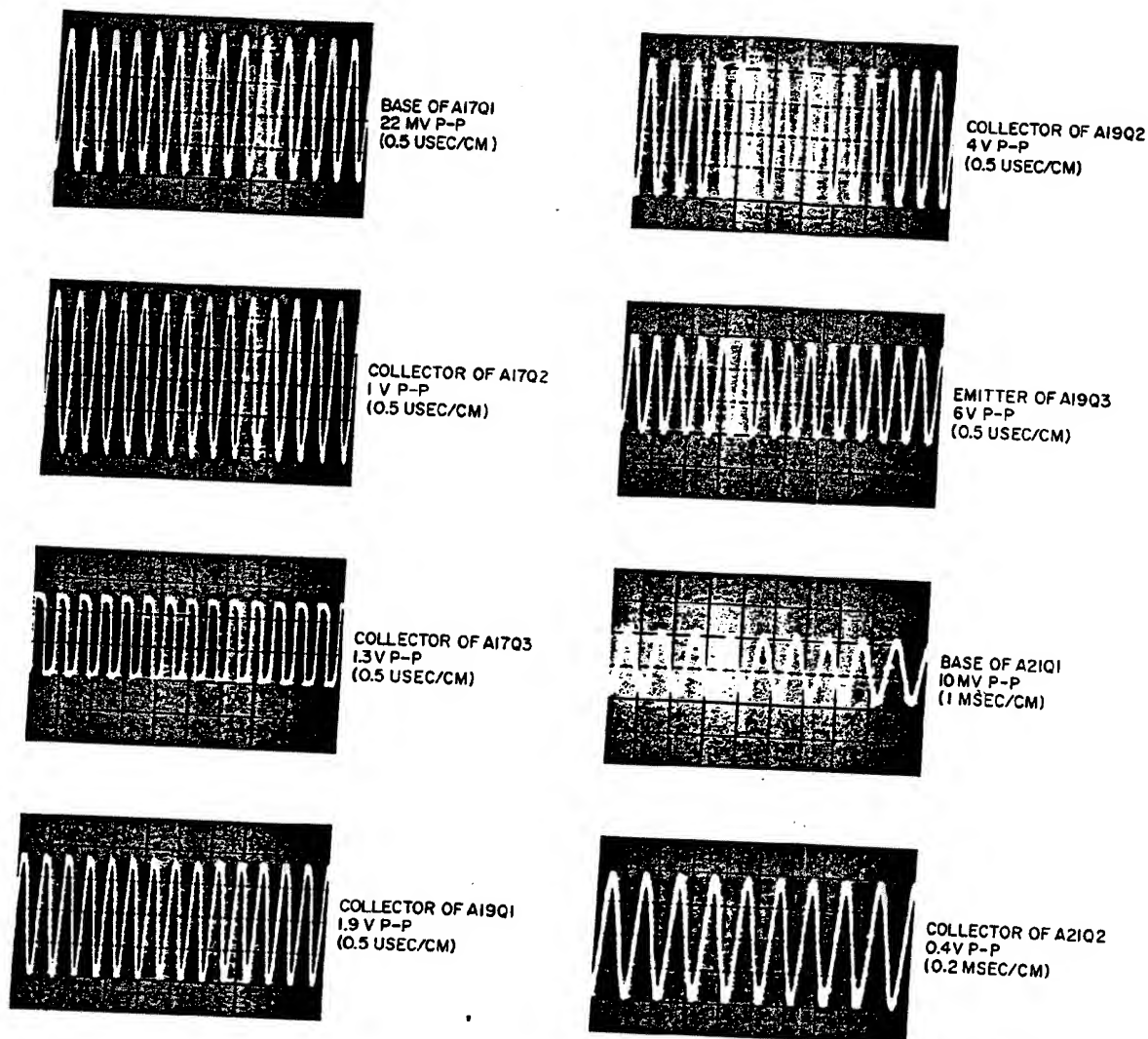


Figure 5-19. Active LPP,
Second Mixer Pair
5-29/5-30

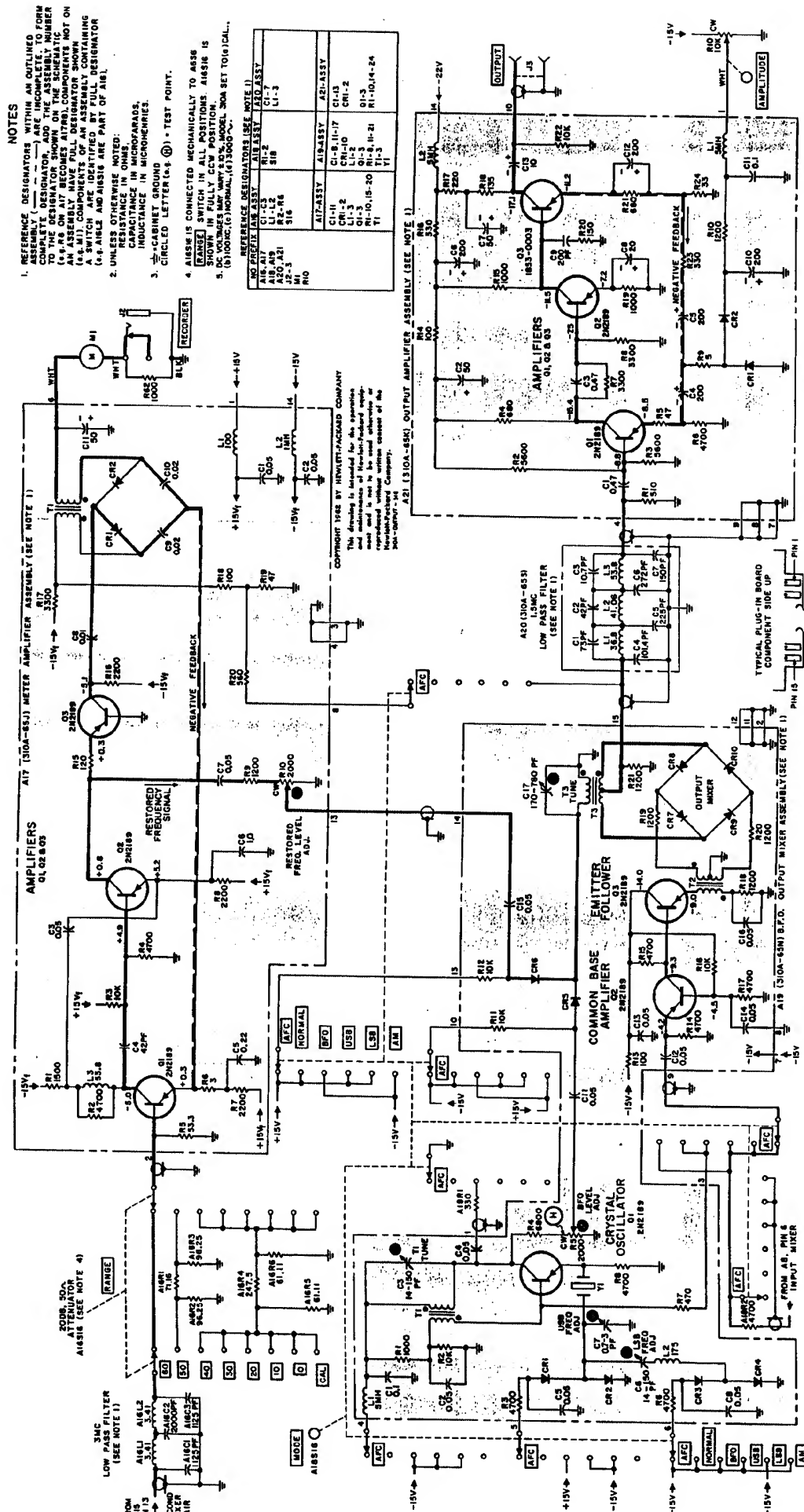


310A-G-3

MEASUREMENT CONDITIONS:

- Model 310A set to NORMAL, 10 kc, 3000 cps, AMPLITUDE cw, 1V, and ODB.
- Model 175A with X10 probe set to 0.1 msec/cm, and appropriate vertical sensitivity.
- Model 200S Oscillator set to 10 kc, and for a 1-volt Model 310A meter reference.

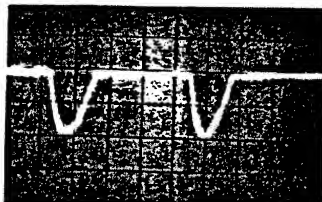
Figure 5-20. Meter, BFO, and Restored Frequency Output Waveforms



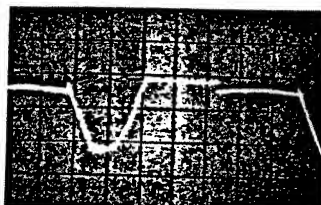
**Figure 5-21. Meter, BFO, Restored
Frequency Output**
5-31/5-32



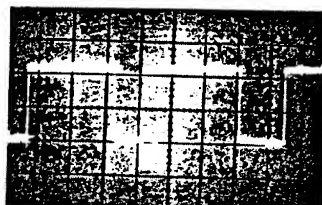
BASE OF A22Q1 OR A22Q3
230 MV P-P
(10 MSEC/CM)



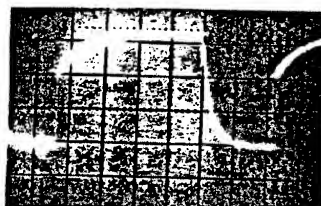
EMITTER OF A22Q2
1 V P-P
(10 MSEC/CM)



BASE OF A22Q4
4.4 V P-P
(10 MSEC/CM)



TEST POINT K
12 V P-P (10 MSEC/CM-
INPUT FREQUENCY BELOW
DIAL READING)



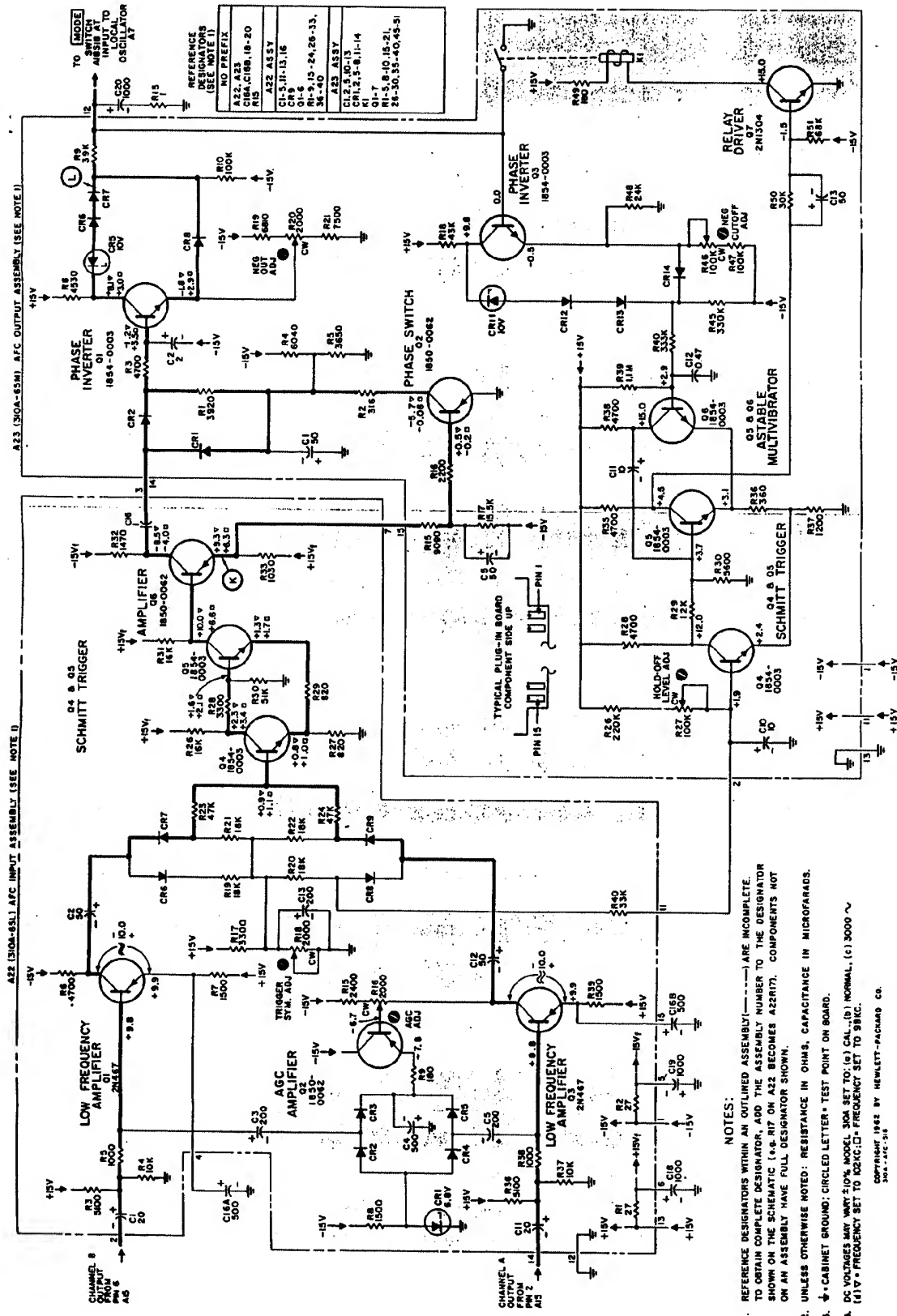
COLLECTOR OF A22Q6
17 V P-P
(10 MSEC/CM)

310A-C-2

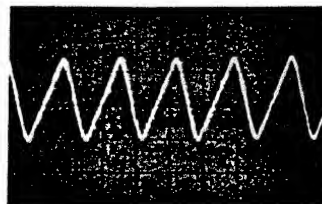
MEASUREMENT CONDITIONS:

- Model 310A set to NORMAL, 10 kc, 3000 cps, AMPLITUDE cw, 1V, and ODB.
- Model 175A with X10 probe set to 0.1 msec/cm, and appropriate vertical sensitivity.
- Model 200S Oscillator set to 10 kc, and for a 1-volt Model 310A meter reference.

Figure 5-22. Automatic Frequency Control Waveforms



**Figure 5-23. Automatic
Frequency Control**
5-33/5-34



COLLECTOR OF Q1 OR Q3
1.2 V P-P
(5 MSEC/CM)

310A-8-2

MEASUREMENT CONDITIONS:

- a. Model 310A set to NORMAL, 10 kc, 3000 cps, AMPLITUDE cw, 1V, and ODB.
- b. Model 175A with X10 probe set to 0.1 msec/cm, and appropriate vertical sensitivity.
- c. Model 200S Oscillator set to 10 kc, and for a 1-volt Model 310A meter reference.

Figure 5-24. Power Supply Ripple

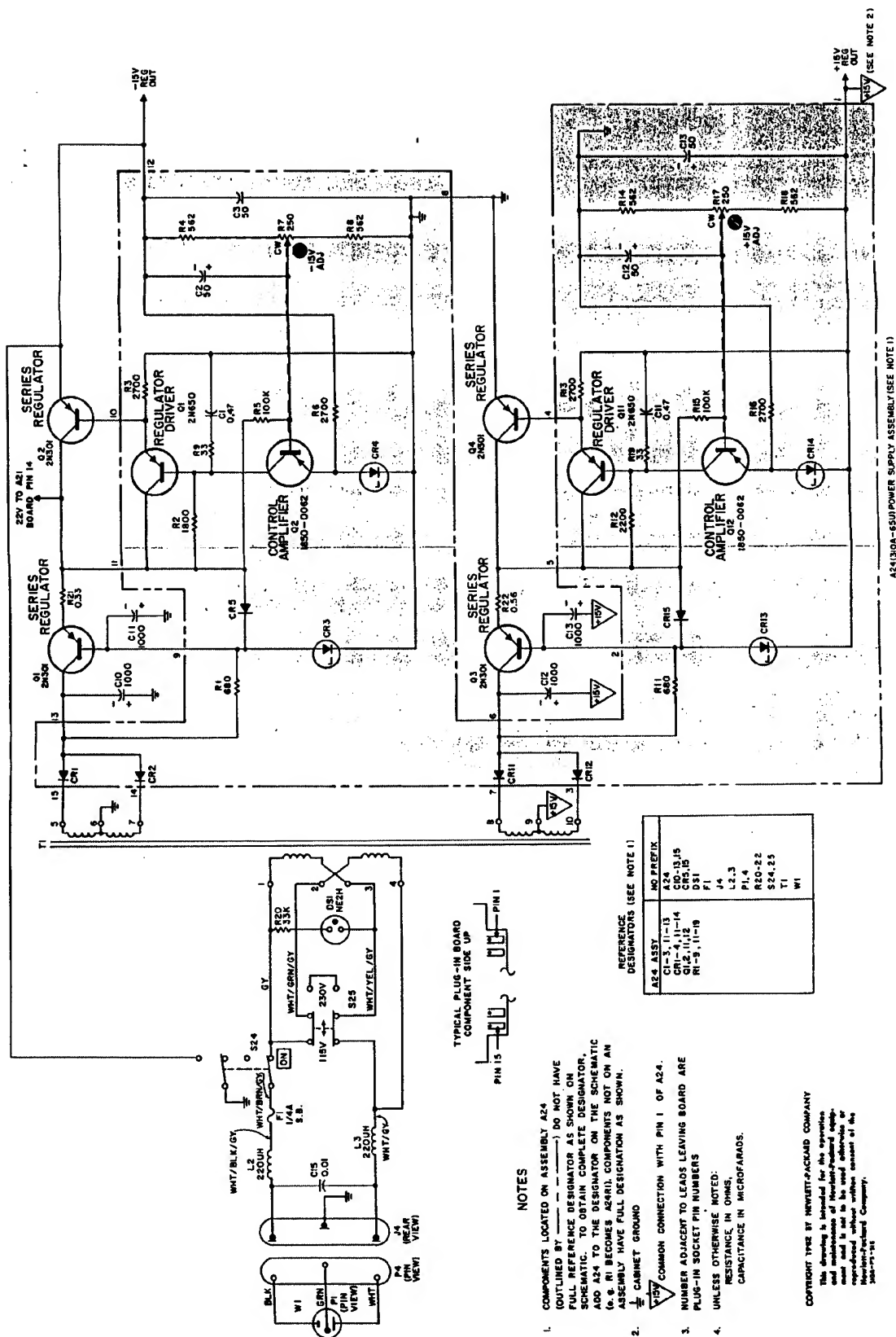


Figure 5-25. Power Supply
5-35/5-36



Figure 5-26. Light Switching Sequence
5-37/5-38

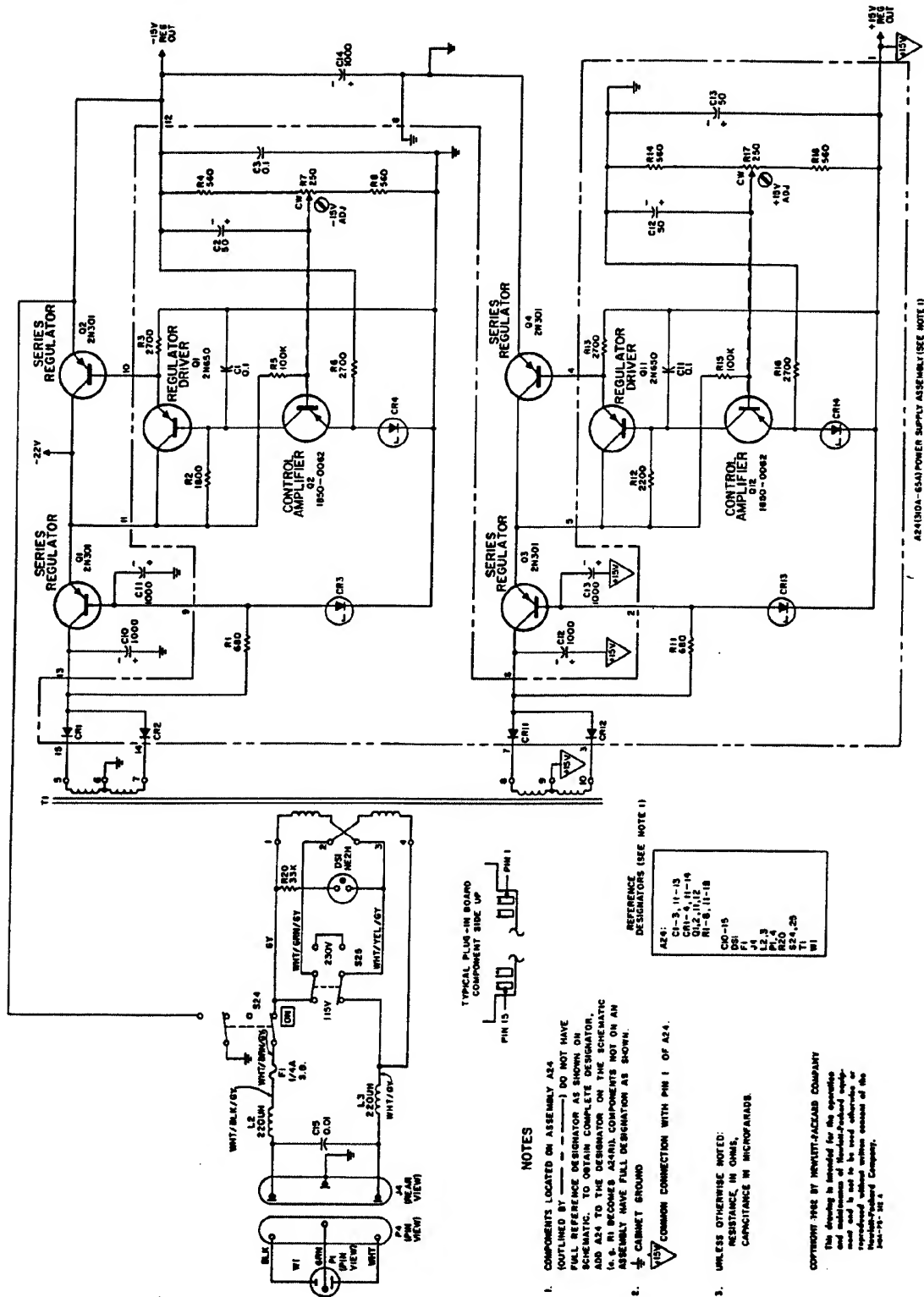


Figure 1A. Power Supply (for serial numbers 404-00560 through 312-)

APPENDIX I

MANUAL CHANGES

This manual applies directly to the 310A Wave Analyzer having serial numbers prefixed 516. This manual with the following changes also applies to 310A Wave Analyzers having serial numbers prefixed 312, 325, 404, 415, 436, 452, and 507. For 310A Wave Analyzers with serial prefix larger than 516, a change sheet should be included with this manual. If the change sheet is missing, the information can be supplied by your nearest Hewlett-Packard Company field office (see List of Sales Offices at the rear of this manual).

To adapt this manual to instruments with serial numbers prefixed other than 516, make manual changes as indicated below.

SERIAL PREFIX OR NUMBER	MAKE MANUAL CHANGES	SERIAL PREFIX OR NUMBER	MAKE MANUAL CHANGES
312-	1	436-	1, 2, 3, 4, 5
325-	1, 2	452-	1, 2, 3, 4, 5, 6
404-	1, 2, 3	507-	1, 2, 3, 4, 5, 6, 7
415-	1, 2, 3, 4	Other	Refer to Manual Changes Sheet, if any.

Change 1: For instruments serial numbered 312-00181 to 312-00285, a 3/8-inch-diameter hole is not provided and must be drilled or punched for the addition of Option 01 100-kc Crystal Calibrator. Refer to Appendix II (Service Note 310A-1 details the exact location of this hole).

Change 2: (see Note 1)

Figure 5-21, Meter, BFO, Restored Frequency Output:
Change A21C9 from 200 pF to 82 pF.

Table 6-1, Reference Designation Index:

A21C8: Change HP Stock No. from 0180-0076 to 0180-0045 (however, note that 0180-0076 is the recommended replacement).

Change: A21C9 to HP Stock No. 0140-0006; C:fxd 82 pF 10% 300 VDCW.

Table 6-2, Replaceable Parts:

Delete: HP Stock No. 0140-0090.

Change the "TQ" for HP Stock No. 0180-0076 to 1.

Add: HP Stock No. 0140-0006; C:fxd 82 pF 10% 300 VDCW; Mfr 00853; Mfr Part No. RCM15E820K; TQ 1.

NOTE 1

12- to 20-Mc oscillations are sometimes found in the output amplifier . . . the solution to this problem is to replace A21C9 with 200 pF capacitor (HP Stock No. 0180-0076). See Table 6-2 for description.

Change 3: (See Note 2)

Figure 5-25, Power Supply:
Replace with Figure 1A.

Table 6-1, Reference Designation Index:

Delete: A24CR5, A24CR15, A24R9, A24R19, R21, R22.

Change: A24C1, A24C3, and A24C11 to HP Stock No. 0150-0084; C:fxd ceramic 0.1 μ F +80%, -20% 50 VDCW.

Add: C14, HP Stock No. 0180-0056; C:fxd electr 1000 μ F 50 VDCW

CHANGE 3 Table 6-2, Replaceable Parts:

(Cont'd)

Delete: HP Stock Numbers 0687-3301, 0812-0019, 0812-0022, and 1901-0026.

Change the "TQ" for HP Stock No. 0180-0056 from 4 to 5; 0160-0174 from 6 to 4; 0180-0058 from 14 to 13.

NOTE 2

The power supply in instruments Serial Prefixed 436 and above is protected against short circuits. The power supply in earlier models may be modified or replaced with a new supply. A new supply board may be ordered as part of the power supply modification kit, Stock Number 00310-600. Hewlett-Packard Service Note 310A-2 describes power supply modification for over-current protection.

CHANGE 4: (See Note 3)**Figure 5-19, Active LPF, Second Mixer Pair:**

Delete: A13C3, A13C4, A13R23, A13R24, A14C3, A14C4, A14R23, and A14R24.

Change: A13C2 and A14C2 from 510 pF to 220 pF.

Table 6-1, Reference Designation Index:

Delete: A13C3, A13C4, A13R23, A13R24, A14C3, A14C4, A14C23, and A14R24.

Change A13C2 and A14C2 to HP Stock No. 0140-0083; C:fxd mica 220 pF 5% 300 VDCW.

Table 6-2, Replaceable Parts:

Delete: HP Stock No. 0140-0017, and HP Stock No. 0160-0362.

Change: the "TQ" for HP Stock No. 0687-3311 from 4 to 2.

Add: HP Stock No. 0140-0083, C:fxd mica 220 pF 5% 300 VDCW; Mfr 28480; Mfr Part No. 0140-0083; TQ 2.

NOTE 3

The manufacturer of the transistors used in the LOW PASS IF AMPLIFIER CIRCUITS (A13 and A14 assemblies) has changed the Alpha Cutoff Frequency characteristic. If any transistors are changed in either of these two circuits, oscillations may occur. If oscillation occurs, add resistors R23, R24, and capacitors C3 and C4 as shown in Figure 5-19. Also, change the value of C2 to 510 pF. If oscillations do not occur, let circuit remain as indicated above.

Change 5: Page 1-0, Table 1-1, RECORDER OUTPUT:

Change statement to read: "1 mA dc into 1500 ohms or less for single ended recorders."

Page 5-31/5-32, Figure 5-21, Meter, BFO, Restored Frequency Output Schematic:Change A17C11 from 50 μ F to 200 μ F.

Delete R62, 100 ohms.

Add connection between J2 shorting contact and ground.

Table 6-1:Change A17C11 stock number and description to read as follows: 0180-0060 C:FXD ELECT 500 μ F -10% +100% 3 VDCW.

Delete R62.

Change 6: Table 6-1: Change stock number of A18S1 to 3100-0362.**Change 7: Page 5-35/5-36, Figure 5-25, Power Supply Schematic:**

Change A24R4, R8, R14, R18 to 560 ohms.

Table 6-1:

Change description of A24R4, R8, R14, R18 to read: 0687-5611 R:FXD COMP 560 ohm 10% 1/2W.

Change description of A7CR1 and A7CR2 to read: 0122-0001 VARICAPACITOR: SIL 100 pF 20% 20 VDCW.

APPENDIX II

OPTION 01

The 310A-Option 01 instruments use a 100 kc Crystal Oscillator in place of the 100 kc calibration multivibrator (A3Q1, A3Q2, and associated components). The 100 kc Crystal Oscillator may be used for both amplitude and frequency calibration.

The Option 01 calibration oscillator circuit, with the exception of push-button switch S50 and crystal Y51, is mounted on the same circuit board (A3) as is the standard circuit. The Option 01 details of special wiring, crystal mounting location, testing procedures, replaceable parts identification, and circuit schematic diagram are included in Service Note (#310A-1A) which is printed in this appendix.

SPECIFICATIONS

The specifications for the Model 310A Option 01 are the same as those of the standard Model 310A except for the frequency accuracy of the calibrator, which is as follows:

FREQUENCY ACCURACY

±2 kc to 1.4 Mc

±3 kc to 1.5 Mc

OPERATION

When MARKER switch S50 is depressed, the harmonics of the 100 kc oscillator may be observed on the output meter. Select the one closest to the frequency of interest. With MODE at NORMAL and BANDWIDTH at 200 cps, adjust ZERO SET for maximum meter indication. Set RANGE for an on-scale reading.

SERVICE NOTE

310A-1A

Ⓢ MODEL 310A WAVE ANALYZER All Serials

INSTALLATION OF 100 KC CRYSTAL CALIBRATOR KIT Ⓢ Stock No. 310A-95A

This Service Note outlines the procedure for installing a 100 KC Crystal Calibrator Kit in Ⓢ Model 310A Wave Analyzers, all serials.

Installation of this kit converts your regular Ⓢ Model 310A to an Ⓢ Model 310A, Option 01 instrument which has the following calibrator specifications: CALIBRATOR FREQUENCY ACCURACY: ± 2 KC to 1.4 mc; ± 3 KC to 1.5 mc.

This modification includes replacement of the 100 KC calibration multivibrator with a 100 KC crystal oscillator which may be used for both frequency and amplitude calibration of your Ⓢ Model 310A.

No special tools or test equipment are required for modification.

PARTS SUPPLIED IN KIT, Ⓢ STOCK NO. 310A-95A

<u>Quantity</u>	<u>Description</u>	<u>Ⓢ Stock No.</u>
1	Board assembly, input amplifier calibrator	310A-65T
1	Crystal, 100 KC	0410-0088
1	Bracket, crystal mounting	310A-12H
1	Cable assembly, marker	310A-16W
1	Tube socket	1200-0020
1	Tube clamp	1400-0033
1	Switch, pushbutton	3101-0051
1	Plate, identification	7120-0170
1	Wire, 26 gauge stranded, yellow, 9 inch length	8150-0065
1	Wire, 26 gauge stranded, green, 9 inch length	8150-0052
1	Wire, 26 gauge stranded, white-black-violet, 4 inch length	8150-0193
3	Machine screw, 6-32 x 3/8 inch with lockwasher	2390-0007
3	Nut, 6-32 x 1/4 inch	2420-0003
3	Lockwasher, #6, internal	2190-0007
1	Lockwasher, 3/8" internal	2190-0016
1	Nut, lamp indicator	1450-0044
1	Nut, hex	2950-0030

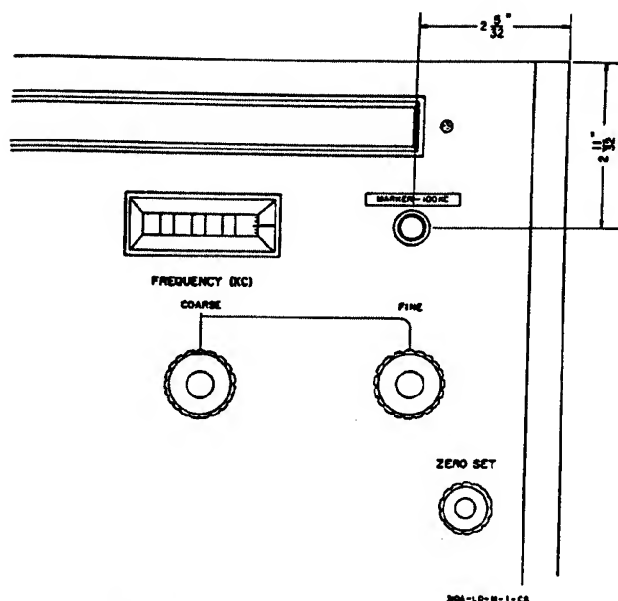


Figure 1. Model 310A, Pushbutton Switch Location

INSTALLATION PROCEDURE

1. Disconnect power and remove power cord.
2. Remove top, bottom and both side covers.
- 3a. Instrument Serial No. 312-00285 and below:

Drill or punch a 3/8" diameter hole in the front panel. Refer to Figure 1 for hole location.

- b. Instrument Serial No. 325-00286 and above:

Remove plug button from 3/8" diameter hole in front panel.

4. Solder the 24 inch long 4-wire cable assembly (310A-16W) to the pushbutton switch assembly. Refer to inset in Figure 2.

5. Mount the pushbutton switch to the panel as illustrated in Figure 2 inset.

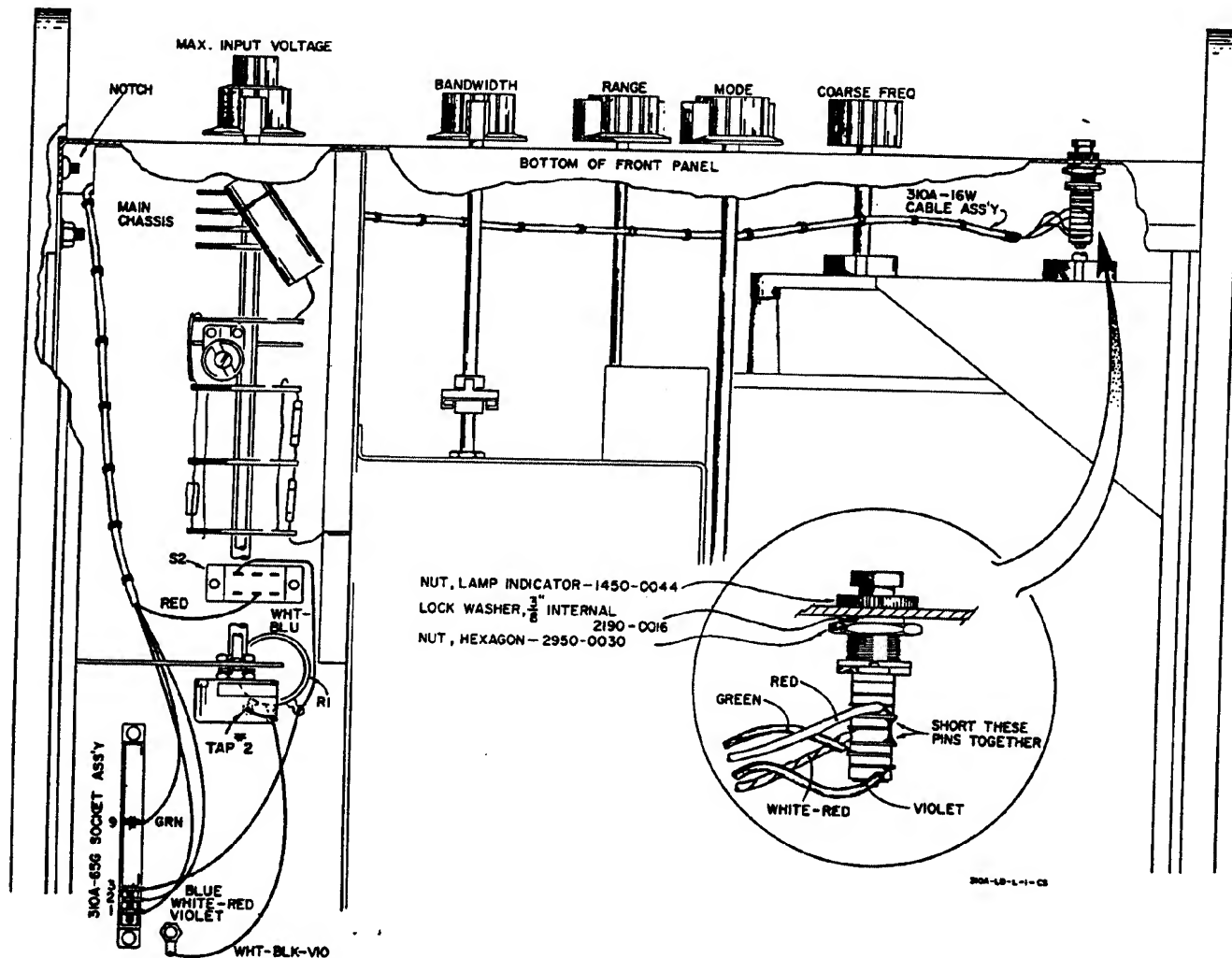


Figure 2. Model 310A, Pushbutton Switch Assembly, Wiring and Cable Layout

6. Dress the cable assembly behind the front panel to the left side of the 310A, then through the notch in the main chassis next to the left side frame. Continue dressing cable to location of 310A-65G socket assembly. Refer to Figure 2.

7. Remove and retain board assembly, 310A-65G.

8a. Instrument Serial No. 312-00285 and below:

1. Remove the white-blue wire from the center tap of R1, 75 ohm pot, and connect it to the same tap on R1 to which the blue wire from pin 3 of the 310A-65G socket is connected.
2. Remove and discard the violet wire connected between tap #2 (see Figure 2) on R1 and Pin 1 of the 310A-65G socket.
3. Short the center tap and #2 tap on R1 and connect the #26 white-black-violet 4 inch wire from this point to the ground lug near pin 1 of the 310A-65G socket.

b. Instrument Serial No. 325-00286 and above:

Remove the white-black-violet wire (connecting the center tap and tap #2 of R1 with pin 1 of the 310A-65G socket) from pin 1 of the 310A-65G socket and connect it to the ground lug near pin 1. See Figure 2.

9. Connect the 4-wire cable assembly (310A-16W) from the pushbutton switch as follows:

- a. Violet to pin 1 on the 310A-65G socket assembly.
- b. White-red to pin 2 on the 310A-65G socket assembly.
- c. Green to pin 9 on the 310A-65G socket assembly.
- d. Red to terminal on S2 indicated in Figure 2.

10. Mount the tube socket and the tube clamp on the crystal mounting bracket as shown in Figure 3.

11. Short pin 2 to pin 3 on the tube socket and connect the nine inch green wire to this point.

12. Short pin 6 to pin 7 on the tube socket and connect the nine inch yellow wire to this point.

13. Remove the extender board assembly, M-65A (new Stock No. 5060-0049) shown in Figure 3. Retain the board and the mounting hardware.

14. Using the hardware removed in step 13, mount the crystal socket assembly bracket to the chassis as shown in Figure 3.

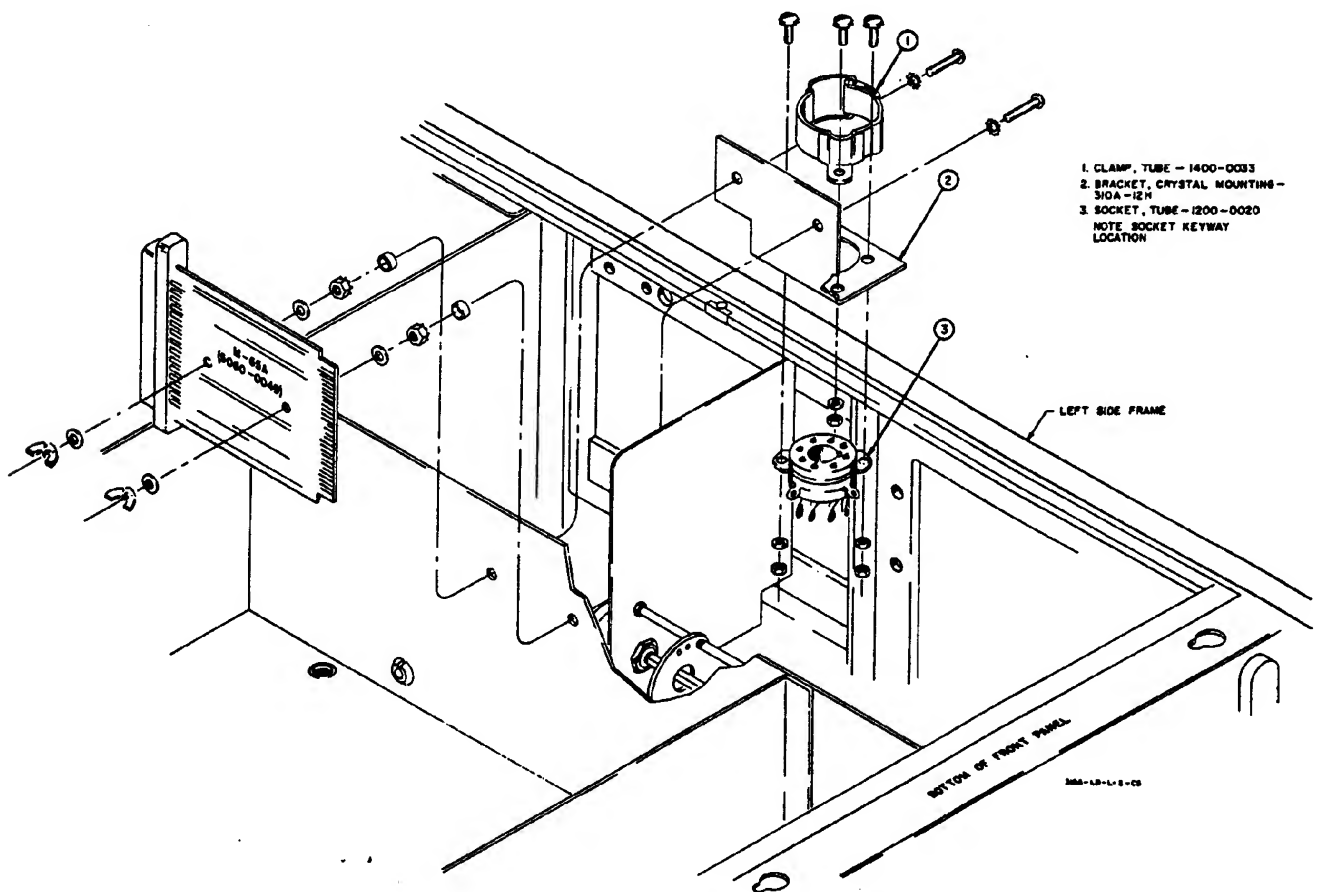


Figure 3. Model 310A, Crystal Socket Assembly

15. Insert the extender board assembly in the 310A-65G socket.
16. Insert the new board assembly, 310A-65T in the extender board socket.
17. Remove the "quick disconnect" connectors attached to the two long pins protruding from the "solder" side of the 310A-65T board assembly and solder to the yellow and green wires from the tube socket.
18. Slip the connectors over the long pins on the board assembly.

Note

They can be connected either way.

19. Insert the crystal (0410-0088) into the tube socket.
20. Check wiring to ensure conformance with the schematic Figure 4.

Note

After the modification has been completed, the 310A-65G Board Assembly can be re-inserted in place of the 310A-65T and the 310A can be operated as a regular instrument if the white-black-violet wire connected between R1 and the ground lug is returned to pin 1 of the 310A-65G socket.

TEST PROCEDURE

1. Connect a 100 K ohm variable resistor, Ⓢ Stock No. 2100-0063, as a rheostat in parallel with capacitor C54. (Use short jumper wires.)
2. Connect a X50 (low capacitance) oscilloscope probe in parallel with Capacitor C54. Use any oscilloscope with better than 100 KC bandwidth vertical amplifier.
3. Connect power cord and turn 310A on.
4. Set RANGE switch to CAL and adjust C54 for maximum sine wave amplitude on the oscilloscope. Vary the rheostat as necessary to maintain a sine wave with no clipping visible on the oscilloscope pattern.
5. Remove the oscilloscope probe and rheostat.
6. Connect the oscilloscope probe between the collector of Q53 and ground. A square wave with 40% - 60% symmetry should be observed. If not, troubleshoot Schmitt Trigger circuit.
7. Depress the pushbutton. The square wave should be differentiated into sharp marker pulses. If not, troubleshoot circuit between Schmitt Trigger and Q5 amplifier.
8. Release pushbutton and disconnect oscilloscope probe.
9. Set FREQUENCY to 100 KC and the ABSOLUTE-RELATIVE switch to ABSOLUTE.
10. Adjust Cal Level Adj. (R1) for full scale meter reading.
11. Depress pushbutton and adjust C56 for approximately 90% full scale meter reading.
12. Repeat steps 10 and 11 until a 100% reading is obtained with the pushbutton released and a 90% reading is obtained with the pushbutton depressed.
13. With the pushbutton depressed, tune the FREQUENCY through the full range. The meter reading should be 30% of full scale or greater at each 100 KC harmonic. If not, troubleshoot all associated circuitry.
14. Turn 310A off. Remove the extender board and remount it on the screws holding the crystal socket assembly bracket.
15. Insert the board assembly 310A-65T in the 310A-65G socket.
16. Replace the top, bottom and side covers.
17. Attach "Marker 100 KC" metal tag to front panel. See Figure 1. A small amount of "Xylene"* will activate the adhesive on the tag.
18. Attach this Service Note to the Operating and Service Manual for your Ⓢ 310A Wave Analyzer for future reference to the schematic, test procedure, and replaceable parts list.

* Xylene, one gallon can, Ⓢ Stock No. 8500-0041.

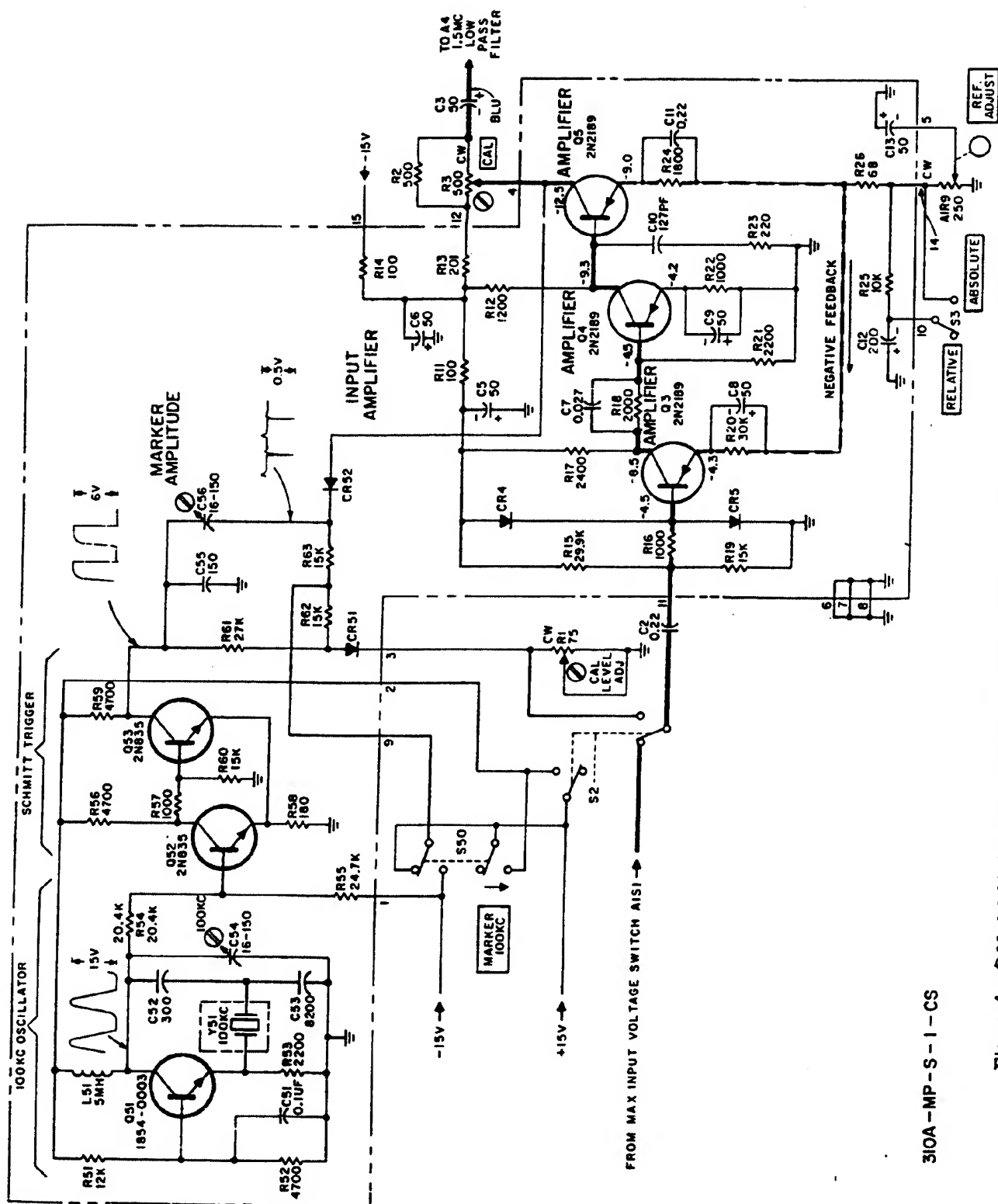


Figure 4. Model 310A Option 01 Input Amplifier-Frequency and Amplitude Calibrator Assembly,
 © Stock No. 310A-65T

REPLACEABLE PARTS LIST

<u>Ckt. Ref.</u>	<u>Stock No.</u>	<u>Description</u>
	310A-65T	Board assy, Input amplifier and calibrator (this assembly consists of the following parts).
C5, 6, 13	0180-0058	Capacitor, fixed 50 μ f 25V
C7	0170-0066	Capacitor, fixed .027 μ f 10%
C8, 9	0180-0033	Capacitor, fixed 50 μ f 6V
C10	0140-0110	Capacitor, fixed 127 pf 2%
C11	0160-0200	Capacitor, fixed .22 μ f
C12	0180-0060	Capacitor, fixed 200 μ f 3V
C51	0170-0085	Capacitor, fixed 0.1 μ f
C52	0140-0225	Capacitor, fixed 300 pf
C53	0140-0184	Capacitor, fixed 8200 pf
C54, 56	0131-0004	Capacitor, variable 16-150 pf
C55	0140-0196	Capacitor, fixed, 150 pf
CR4, 5	1901-0040	Diode Si: 30 ma 13.5 PIV
CR51, 52	1910-0016	Diode, Ge: 100 ma at 1V, 60 PIV
L51	9140-0072	Coil, RF 5000 mh 100 ma
Q3, 4, 5	1850-0096	Transistor, Ge: 2N2189
Q51	1854-0003	Transistor, Si: Special
Q52, 53	1854-0011	Transistor, Si: 2N835
R11, 14	0687-1011	Resistor, fxd, comp, 100 ohms, \pm 10%, 1/2W
R12	0687-1221	Resistor, fxd, comp, 1.2K ohms \pm 10%, 1/2W
R13	0757-0718	Resistor, fxd, met flm 200 ohms 1.0%, 1/4W
R15	0757-0341	Resistor, fxd, met flm 30.1K ohms 1.0%, 1/4W
R16	0690-1021	Resistor, fxd, comp, 1000 ohms, \pm 10%, 1/2W
R17	0758-0034	Resistor, fxd, metal film, 2.4K ohms, \pm 5%, 1/2W
R18	0758-0033	Resistor, fxd, metal film 2.0K ohms, \pm 5%, 1/2W
R19	0757-0757	Resistor, fxd, met flm 15K ohms 1% 1/4W
R20	0758-0079	Resistor, fxd, metal film, 30K ohms, \pm 5%, 1/2W
R21	0758-0044	Resistor, fxd, metal film, 2.2K ohms, \pm 5%, 1/2W
R22	0687-1021	Resistor, fxd, comp, 1K ohm, \pm 10%, 1/2W
R23	0687-2211	Resistor, fxd, comp, 220 ohms, \pm 10%, 1/2W
R24	0687-1821	Resistor, fxd, comp, 1.8K ohms, \pm 10%, 1/2W
R25	0687-1031	Resistor, fxd, comp, 10K ohms, \pm 10%, 1/2W
R26	0687-6801	Resistor, fxd, comp, 68 ohms, \pm 10%, 1/2W
R51	0687-1231	Resistor, fxd, comp, 12K ohms, \pm 10%, 1/2W
R52, 56, 59	0687-4721	Resistor, fxd, comp, 4.7K ohms, \pm 10%, 1/2W
R53	0687-2221	Resistor, fxd, comp, 2.2K ohms, \pm 10%, 1/2W
R54	0698-3222	Resistor, fxd, met flm 20.5K ohms, 1% 1/4W
R55	0698-3217	Resistor, fxd, met flm 24.9K ohms, 1% 1/4W
R57	0687-1021	Resistor, fxd, comp, 1K ohms, \pm 10%, 1/2W
R58	0687-1811	Resistor, fxd, comp, 180 ohms, \pm 10%, 1/2W
R60, 62, 63	0687-1531	Resistor, fxd, comp, 15K ohms, \pm 10%, 1/2W

REPLACEABLE PARTS LIST (Cont'd)

<u>Ckt. Ref.</u>	<u>Stock No.</u>	<u>Description</u>
R61	0687-2731	Resistor, fxd, comp, 27K ohms, $\pm 10\%$, 1/2W
Y51	0410-0088	Crystal, 100KC
	1251-0162	Connector, male, printed ckt
	1251-0163	Connector, female, printed ckt
	1200-0020	Socket, tube, octal
	1400-0033	Clamp, tube
	3101-0051	Switch, pushbutton, DPDT
	7120-0170	Plate, identification
	310A-12H	Bracket, crystal mtg
	310A-16W	Cable assy, marker

SERVICE NOTE

310A-2

MODEL 310A WAVE ANALYZERS SERIALS BELOW 415-00561

POWER SUPPLY MODIFICATION KIT

Stock No. 00310-601

This Service Note provides the information necessary for modifying the Power Supplies in Model 310A Wave Analyzers, serials below 415-00561 for improved short circuit protection.

The modification consists of changing the values of three capacitors and adding four resistors and two diodes.

Upon completion of the modification the power supplies will have to be adjusted in accordance with the instructions in the Operating and Service Manual for your Model 310A. No special tools are required for this modification.

Parts Furnished in Power Supply Mod Kit 00310-601

Quantity	Description	Stock Number
2	CAPACITOR, Fixed Ceramic, 0.47 +80%, -20%, 25VDCW For C1 and C11	0160-0174
2	RESISTORS, Fixed Composition, 33 ohms $\pm 10\%$, 1/2 watt For R9 and R19	0687-3301
1	RESISTOR, Fixed Wire Wound 0.33 ohms $\pm 5\%$, 3 watts For R21	0812-0019
1	RESISTOR, Fixed Wire Wound 0.56 ohms, $\pm 5\%$, 3 watts For R22	0812-0022
2	DIODE, Silicon, 200 PIV, 0.5 ma. For CR5 and CR15	1901-0026
1	CAPACITOR, Fixed Electrolytic 50 μ f, -10% +100%, 25 VDCW For C3	0180-0058

MODIFICATION PROCEDURE

1. Disconnect power, remove top and bottom covers.
2. Remove the Power Supply Board 310A-65A.
3. On 310A-65A, remove and discard C1, C11, and C3.
4. Install the 50 μ f, 25v Electrolytic in place of C3.
5. Install the two 0.47 μ f, 25v ceramic capacitors in place of C1 and C11.

6. On the foil side of 310A-65A remove approximately 1/4 inch of foil connecting C1 to Q1, and 1/4 inch of foil connecting C11 to Q11.

7. Solder the two 33 ohm resistors to the foil side of the board between C1 and Q1 and between C11 and Q11.

8. Remove and discard wire between emitter of Q1 and collector of Q2 on chassis.

9. Connect the 0.33 ohm resistor R21 between the emitter of Q1 and the collector of Q2.

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01967-2

10. Connect Diode CR5 cathode to the base of Q1. Connect the Anode to the collector of Q2.
11. Remove and discard wire between the emitter of Q3 and collector of Q4.
12. Connect the 0.56 ohm resistor R22 between emitter of Q3 and collector of Q4.
13. Connect CR15 cathode to base of Q3. Connect Anode to collector of Q4.
14. Remove and discard the black wire and the purple wire connecting C14 to the terminal strip next to the Power Supply Assembly.
15. Remove and discard C14.

This completes the modification. The Power Supplies should be adjusted in accordance with the instructions in the Operating and Service Manual for your Wave Analyzer.

Note

The Modified Power Supply is now equivalent to the Φ Stock Number 310A-65U Power Supply Assembly. The only difference is that Diodes CR5 and CR15 are mounted on the Φ 310A-65U Assembly.

Save this Service Note for future reference when servicing the Power Supply in your Wave Analyzer.

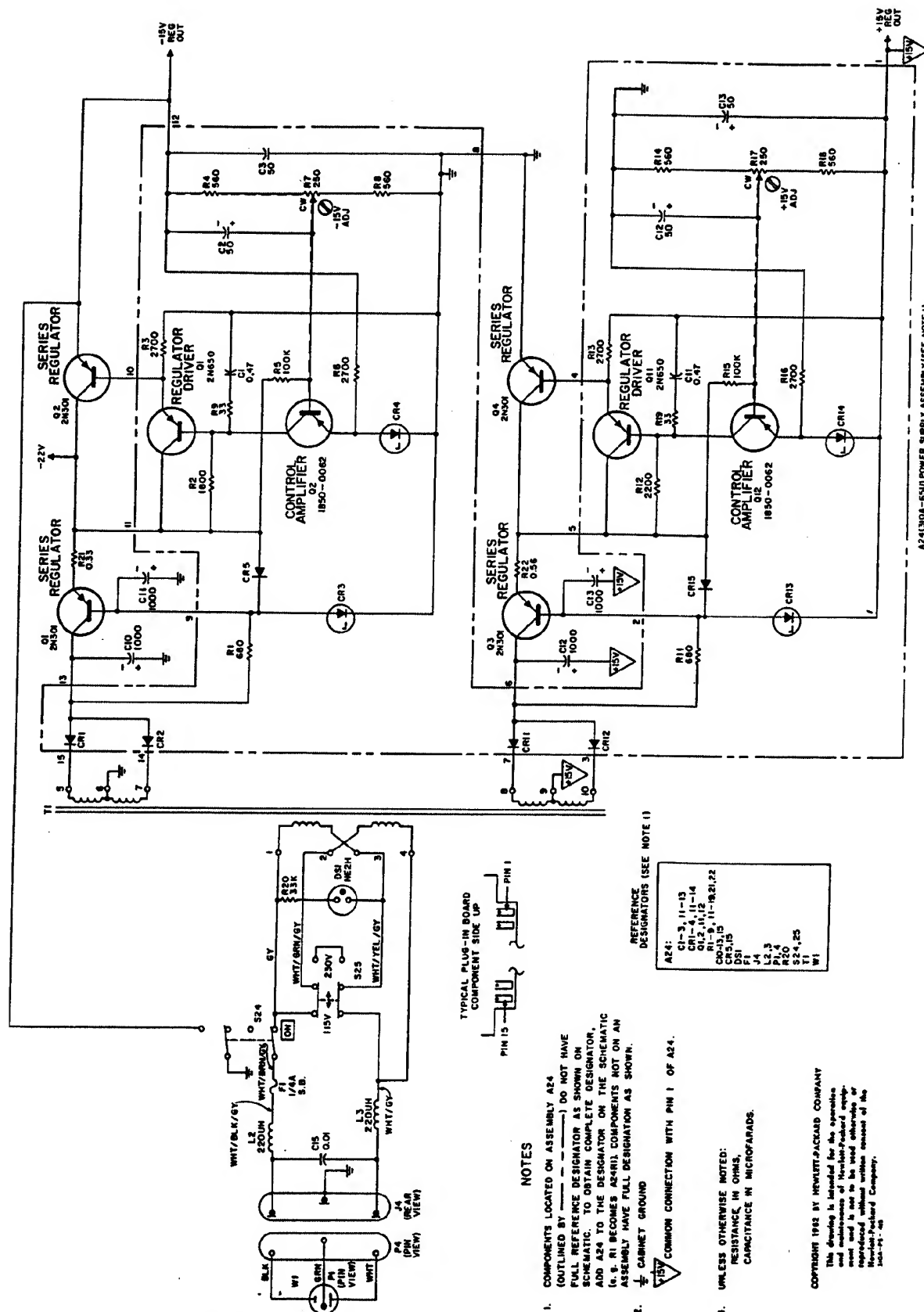


Figure 1. Power Supply After Modification